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ABSTRACT

Since no civilization can survive without a healthy environment, people must learn to live in harmony with their natural ecosystems and build for future generations. This guide describes six award-winning programs on the condor, black-footed ferret, panthers and cheetahs, ducks, farming and wildlife, and the Galapagos Islands. Although each program focuses on a different species or aspect of the natural world, each uses the same theme that all life on Earth is interconnected. Ways people can make a difference in protecting the environment and reasons for conserving the natural heritage are also outlined. Each program includes: (1) objectives outlining instructional goals and material in the chapter; (2) a program summary that introduces and reviews the issues and highlighted information; (3) background material; (4) pre-viewing activities with suggested procedures for teachers; (5) discussion questions; and (6) follow-up activities with suggestions for additional projects. At the end of the guide, instructional resources include a glossary, directory to agencies and organizations that can provide more information, list of references, and a map of the United States. (RT)

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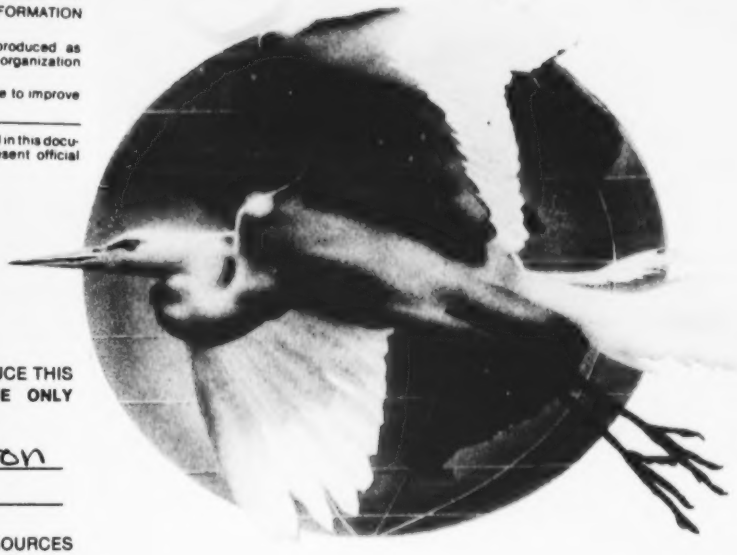

NATIONAL AUDUBON SOCIETY SPECIALS

TEACHER'S GUIDE I

CONDOR

THE MYSTERIOUS BLACK-FOOTED FERRET

ON THE EDGE OF EXTINCTION: PANTHERS AND CHEETAHS

DUCKS UNDER SIEGE

COMMON GROUND: FARMING AND WILDLIFE

GALÁPAGOS: MY FRAGILE WORLD

SE049 419

NATIONAL AUDUBON SOCIETY
801 Pennsylvania Ave., S.E.
Washington, DC 20003

WETA/TELEVISION
P.O. Box 2626
Washington, DC 20013

Dear Teacher:

WETA and the National Audubon Society are pleased to bring you this guide. We have designed it so that you will be able to gain the maximum instructional value from the programs of the *National Audubon Society Specials*.

These award-winning programs are about wildlife and the natural world. They offer students a dramatic look at the wonders of nature, including some of the world's rarest creatures. At the same time, the programs stress the importance of conserving our natural heritage today and for generations to come.

Since no civilization can long survive without a healthy environment, we must learn to live in harmony with our natural ecosystems. We must learn to build for future generations, rather than steal from them, so that our children and grandchildren can enjoy a healthy and life-sustaining environment. Each and every one of us holds in our hands, and in our hearts, the power to ensure habitat and species survival. We have the ability to make this world a better place for wildlife and mankind alike. We will make a difference and shape the future if we are determined to do so.

Each program focuses on a different species or aspect of the natural world. But the same message runs through every program: all life on Earth is interconnected. The fate of the human race, like that of wild creatures, depends on the health of our planet's air, water and soil. The programs also show how people can make a difference in protecting the environment.

The series has won more than three dozen national and international film and television awards for excellence. Each program is co-produced by the National Audubon Society, Turner Broadcasting System and WETA/TV, the public broadcasting station in Washington, D.C., and is financed with a major grant from the Stroh Brewery Company. These four organizations offer the videocassettes and the teacher's guide to schools and libraries with the conviction that the cassettes and the guide say something important about the world's future. The programs air on SuperStation TBS before appearing on public television stations throughout the nation.

The programs and guide are suitable as resource materials for science courses in grades seven through nine. This guide includes summaries of the television programs, background information, objectives, pre-viewing activities, discussion questions, suggested follow-up activities, an annotated bibliography, a glossary, and a resource list. For teachers who want more background reading on these environmental issues, a beautifully illustrated companion book to the *National Audubon Society Specials* has now been published by Harcourt Brace Jovanovich, entitled *Life in the Balance*. It is available in bookstores throughout the country. Companion computer software will also soon be available. We believe integrating print, video, and software will increase a student's interest in conservation that much further and faster.

This teacher's guide has been written by Roger DiSilvestro of the National Audubon Society. Roger is currently a senior editor of *Audubon* magazine and was previously the editor and production director of *Audubon Wildlife Report*. He holds a B.S. and M.S. in zoology from the University of Nebraska and an M.A. in journalism from the University of Oklahoma.

We are grateful to Marshal Case, Vice President for Education at the National Audubon Society, for his support on this project. Among other responsibilities, Marshal runs Audubon's youth education program, *Audubon Adventures*. For further information about *Audubon Adventures*, please contact the National Audubon Society, Education Division, Route 4, Sharon, CT 06069, phone 203/364-0520.

Other people whose help on this teacher's guide we gratefully acknowledge include David Clark, Deborah Clark, Ada Graham, Jessie Grantham, Maureen Hinkle, Larry Kruckenberg, Cynthia Lenhart, Lea MacNider, John Pancella, Jean Porter, Gary Rowe, Phil Schaeffer, Sharon Schirmer, Delores Simmons, and Mark Stromberg.

Please write to us if you have any questions or need further information.

Sincerely,

Christopher Palmer

Christopher N. Palmer
Executive Producer
Audubon Television Specials, and
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Additional copies of this guide and videocassettes of the programs can be purchased from WETA-TV. Please write or call WETA-TV, Department of Educational Activities, P.O. Box 2626, Washington, DC 20013, (800) 445-1964 or (703) 998-2709.

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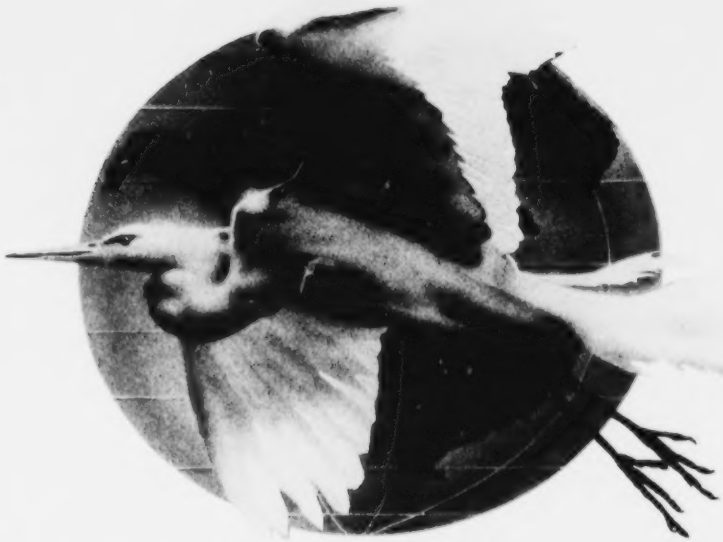

NATIONAL AUDUBON SOCIETY SPECIALS

TEACHER'S GUIDE I

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Using This Guide

Each chapter in this guide corresponds to one of the *National Audubon Society Specials* and provides instructors with the following:

Objectives outlining the instructional goals of the program and the material in the chapter.

A **Program Summary** that introduces and reviews the issues and information highlighted in the program.

Background Material that augments material in the program.

Pre-viewing Activities that suggest procedures teachers should take to introduce students to the content of the program.

Discussion Questions that a teacher may use to initiate debate and inquiry about the conservation challenges, political issues, and biological theories presented in the program.

Follow-up Activities that suggest additional projects to further students' understanding of the issues raised in the program.

At the end of the guide are the following instructional resources:

A **Glossary** of terms used in the programs and the teacher's guide; words that appear in the glossary are printed in boldface in the text.

A **Directory** to agencies and organizations that can provide more information on the material in the programs.

A **List of References** for further reading and inquiry.

A **Map** of the United States that may be photocopied for students' use.

Before showing one of the programs to your class, read the corresponding section of the guide from beginning to end. Then:

1. Watch the program yourself, and read the program summary and background sections.

2. Prepare your students by taking part in preview activities. You may wish to use the background materials as a reading assignment for your students prior to watching the program. If so, they may be photocopied.

3. Have your class view the program.

4. After the program, review the main points and use the discussion questions to spark discussion and further exploration.

5. Choose the follow-up activities with which you wish to work. (Some of these may require advanced planning. You may need to order special materials.)

Condor

After viewing the program and participating in the activities suggested here, your students will be able to:

- *Describe and identify the California condor, map its former range, and prepare reports or class presentations about the bird's survival problems, range, habitat, and behavior.*
- *Analyze the ecological role played by the California condor in the wild.*
- *Describe the jeopardy which biological specialization can place on a species' survival.*
- *Evaluate the meaning and value that wild creatures such as the condor have for humankind.*
- *Evaluate the conflicts that have arisen between humans and wildlife.*
- *Describe how biologists learn about animal behavior through radio-telemetry work.*
- *Analyze how experts differ in how they think conservation problems should be solved.*
- *Analyze the difficulties of trying to breed wild animals in captivity.*
- *Evaluate a species' chances of survival based on its birth and death rates.*
- *Describe the federal Endangered Species Act and evaluate the protections it gives to vulnerable species.*
- *Propose plans of action that may help certain species.*

PROGRAM SUMMARY

The California condor is a gigantic soaring vulture with a wingspan of nearly ten feet. It once ranged widely over much of North America, but by the mid Twentieth Century was restricted to southwestern California. Today, only twenty-seven California condors survive, all in zoos. However, when the *National Audubon Society Special, Condor* was made, six birds were still free. The program tells the story of the desperate effort made by a group of biologists to save these birds. The biologist worked for the Condor Research Center, run jointly in Ventura, California, by the U.S. Fish and Wildlife Service and the National Audubon Society with the assistance of the California Department of Fish and Game. The effort to save the condors also required the cooperation of the U.S. Forest Service, Bureau of Land Management, San Diego and Los Angeles zoos, and members of the academic community.

To help protect condors, biologists:

- Distributed livestock carcasses at various sites used by condors to help reduce deaths from poisoned and contaminated food sources. From 1983 to 1986, all four known condor deaths were caused by poisoned baits put out for predators or by lead poisoning from bullets that the birds ate while feeding on the carcasses of animals that had been shot.
- Collected data on condor distribution and behavior by tagging adult birds with radio transmitters. The transmitters permitted the tracking of the birds from great distances. Other data also were collected from young birds in nests, allowing biologists to create complete life histories of individual birds.
- Initiated captive-breeding programs in an attempt to rear birds in a protected environment. In 1983, eggs removed from the wild were successfully hatched at the San Diego Zoo. Condors kept at the San Diego and Los Angeles zoos include birds hatched and reared in captivity and adult birds taken from the wild. The primary goal of the breeding effort is to reestablish a viable wild population by releasing some of the captive condors. Before the birds can be released biologists will need to understand better the survival problems the birds face in the wild. Otherwise, released birds might simply dwindle away.

The condor is clearly threatened with extinction. But as researcher Noel Snyder says, "There have been species that have come back from numbers that are lower than what we have with the condor now."

A valiant attempt is being made to save the condor. Time and nature, as the program points out, will determine its success.

BACKGROUND MATERIAL

Condor Prehistory and Decline. Fossil condor bones discovered in Genesee County, New York, in 1986 suggest that the decline of the California condor actually may have begun thousands of years ago. The site where the fossils were found also suggests that condors once ranged well beyond the southern and western regions to which biologists have traditionally believed they were restricted.

Palentologists who have studied the eleven-thousand-year-old bones believe that ancient condors fed on the massive remains of mammoths, giant beavers, giant sloths, and other large ice age mammals. As these mammals edged into extinction milennia ago, the condor lost its primary food source. Too large to feed on smaller animals, the condor itself began to ebb away. The twenty-seven surviving birds may be the last participants in an ancient struggle against oblivion.

By the time Lewis and Clark made their historic journey to the Pacific Northwest in the first decade of the Nineteenth Century, the condor was restricted to the West Coast, from Baja California to British Columbia. What large food sources would have permitted its survival there? Perhaps the carcasses of whales washed up on beaches, or the bodies of sea lions that reach some five hundred pounds, or the quantities of flesh left during salmon runs, when thousands upon thousands of the fish rush up streams to breed and then die.

More certain is the cause of the condor's decline in the Nineteenth Century. Settlers shot them in such numbers that hunting alone would have jeopardized the birds' survival. The settlers also reduced the numbers of deer, fish, whales, and other creatures upon which condors fed. By the turn of the Twentieth Century fewer than a hundred California condors remained. Their numbers continued to dwindle through the ensuing decades, but the cause for the decline is not clear. It may have been lack of food, or loss of habitat as human development increased, or shooting, or all of these things. In 1971 only fifty or sixty remained. Four years later, they numbered less than forty. As the program illustrates, the decline hastened in the early 1980s. In 1987, the last of the wild condors was taken into captivity.

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PRE-VIEWING ACTIVITIES

Have your students read the background material. Feel free to photocopy. Point out to your students that the condor was a contemporary of the woolly mammoth, saber-toothed tiger, giant beaver, and giant sloth. Ask them to find out what other animals were contemporaries of the condor ten thousand years ago. If the animals are extinct, ask your students to find out why. Have them try to explain why the condor survived.

DISCUSSION QUESTIONS

Many of the following questions lack definitive answers. They are meant to stimulate discussion about the condor and investigation into the problems that confront endangered species.

1. In the opening of the program, the narrator says, "The handful of California condors existing today is a reminder of the prehistoric world, a tribute to survival in a changing world." Later he says, "Large amounts of money and human resources are being expended to save them. Is it too late? Has the time of the condor already passed?" Do you think that the condor's existence is a tribute to survival? Or do you think the condor is a creature whose time has passed? Why? How do you tell if a species time has passed?

2. The narrator says, "In the Twentieth Century, extinctions have been accelerated to an unnatural rate." Some biologists predict that a million species will become extinct by the end of the century. Do you think the time of these species has passed too? What would cause the acceleration of extinction rates? Did massive extinctions ever occur in prehistoric times?

3. The program shows a group of people who gather each year to watch condors. One of the watchers says, "We'll keep having condor watches if only to keep the faith, even if all the birds are in captivity." Why would these people get together even if the condors were gone? Why would they watch empty skies? Do you think these people are watching just condors? Or do you think the condor represents something for them that goes beyond the bird itself? What could this be? Remember that toward the end of the program the narrator points out that, "For all involved, the condor is an emotional and philosophical as well as a scientific issue." What kind of "condors"do you have in your life? How would you feel if they disappeared?

4. Why protect condors anyway? Hint: Remember that the narrator said, "By preserving the condor, we are doing far more. We are protecting the land and all of its creatures." Does this justify condor protection? Does it justify the protection of other animals?

5. In the program we are told that the condor's primary feeding habitat "is on privately owned lands which are increasingly attractive to developers." What does this suggest might happen to the condor in the future? What alternatives exist? Hint: In 1987 the federal government bought some private land and designated it as a condor refuge.

6. In the program we saw biologists helping a young bird hatch from an egg. The narrator said this was done because the hatchlings sometimes die as a result of their struggles to escape the eggs. But does this mean the biologists are helping weaker birds to survive? Will they pass on their weakness to future generations? What effect could this have on the birds twenty years from now? Is the risk worth taking?

7. Is manipulation of condors by biologists good or bad? What does the program tell us has happened because of such activities? Hint: One young bird died from the stress of handling; birds in captivity risk **imprinting** on humans; but on the other hand, perhaps more birds have survived in captivity than would have in the wild.

8. A lot of work and money is going into condor recovery. One biologist is quoted in the program as saying of the condor, "It's an incredibly spectacular creature that just demands this kind of attention." What about less spectacular creatures? Should we worry about the survival of small fish, or snails, or clams? Why? Why not? Hint: A snail may be food for a small fish, that is food for a bigger fish, that is food for an eagle, that kills prey that may benefit scavengers such as the condor. All species are linked in the quest for survival. Nevertheless, it is true that the bulk of endangered species work is devoted to big, appealing animals, while smaller, less attractive creatures are largely ignored. Invertebrates, for example, comprise only a small percentage of the species on the federal endangered species list. What does this suggest about the protections provided by the **Endangered Species Act**.

9. Biologists are studying golden eagles to see if levels of various environmental poisons are at high levels in the eagles' blood. The narrator says that poison levels in the blood of eagles may correspond to levels in the condor, warning biologists about the dangers to condor's fate. Do you think what happens to wildlife, particularly endangered species, provides similar warnings about what might happen to humans living in the same area? Hint: In Green Bay, Wisconsin, cormorants and other shorebirds are showing unusually high numbers of birth defects, apparently because of toxins in the water and in the fish the birds eat. The human rate of miscarriages in the area also exceeds the national average.

10. The narrator says, "California is a state whose face is forever changed. Water flows and crops grow where only desert once existed." How would human-brought changes affect the condor? What examples can you think of? Do you think condor survival could be affected by replacing wild animals that occur within condor range, such as deer, with livestock? How?

11. If the effort to recover the condor fails, what effect do you think the failure will have on other efforts to save endangered species?

12. Many people who care about condors have argued that the birds should not be brought into captivity, even if leaving the birds in the wild dooms them to extinction. They say the condor should be allowed a death with dignity. Do you believe some deaths are more dignified than others? How do you think the condors would die if left in the wild? Would those deaths be more dignified than life in captivity?

13. Ravens ate at least one condor egg while the birds were still in the wild. How do you feel about the ravens? Should they be killed off in areas where condors nest in order to protect the condors? Is it right to kill one animal to save another?

14. Two captive condor populations have been created. Why not just one?

15. What biological factors make condor survival difficult in the modern world? Hint: Compare the eagle and the condor. The eagle can kill its own food or scavenge. The condor can only scavenge. It is more specialized than the eagle, making it more vulnerable to extinction. Why? Can you think of other highly specialized animals that also face extinction? Hint: In the wild the giant panda eats virtually nothing but bamboo; wild black-footed ferrets eat primarily prairie dogs.

FOLLOW-UP ACTIVITIES

1. In the program we are told that more than a dozen endangered species occur within condor range. Have your students prepare a report on these species. The report should answer the following questions: What are the listed species? Why are they endangered? Are there any activities in the area that cause species to decline? How can the decline be avoided? Which species are surviving well in the area? Why are they doing well? What differences exist between species that fail to survive and those that succeed? Ask your students to try to determine what types of species, as a rule, are most likely to be vulnerable to extinction in a human-dominated world. Have them suggest steps that might be taken to protect species that are particularly vulnerable.

2. Have the class "adopt" an endangered species by following closely any news on the protection and management of a species they select. Some students should report to the class regularly on the status of the adopted species.

3. Invite a speaker from the state wildlife agency or your local Audubon Society chapter to discuss local endangered species with your class and to tell about what the state is doing to protect them. (See resource list for more information).

4. Have your class prepare a report on your state list of endangered species. Ask them to find out why the species are declining and what is being done to help them. Ask them to find out which group of animals appears most frequently on the state list: mammals, birds, reptiles, invertebrates. Ask them to try to determine the reason for the differences in frequencies. Have them find out if the state lists plants. Also ask them to find out if the state lists species that the federal government does not. If it does, have them find out why.

5. Have the class pretend that it is the condor recovery team. Each student can adopt an appropriate role, such as real estate developer, biologist, Forest Service officer, Audubon researcher, and so on. The students should prepare reports on the views they represent and present their reports to the class.

6. The class can hold a trial in which the condor's fate hangs in the balance. Three students can be the judges. Others can serve as witnesses, pretending to be ranchers, biologists, private conservationists, loggers, oil developers, and so on. Each tells why condor recovery should be supported or abandoned. Each witness should prepare a report on the viewpoint he or she represents and present it to the class.

7. Invite a speaker from the local zoo to discuss captive-breeding programs. Investigate the difficulties of inbreeding and what zoos are doing to overcome them.

8. Pick a state-listed endangered species and, using the class as a recovery team, make a recovery plan for the species. This project would involve investigating the species survival problems, costs of recovery, sources of funds, and so on. This project could take all year to complete and could make a real contribution to local conservation work. You can get samples of recovery plans to use as models by contacting the U.S. Fish and Wildlife Service's Office of Endangered Species or by requesting one from your senator or representative in Congress.

The Mysterious Black-Footed Ferret

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After viewing the program and participating in the activities suggested here, your students will be able to:

- *Describe and identify the black-footed ferret, map its past and recent ranges, and discuss its survival problems, habitat, and behavior.*
- *Discuss the ecological roles played by the ferret, the badger, and the prairie dog in the wild.*
- *Analyze the jeopardy biological specialization can place on species' survival.*
- *Evaluate the meaning and value that wild creatures have for humankind.*
- *Explain how a species' survival is intricately tied to its habitat.*
- *Evaluate the conflicts that have arisen between humans and wildlife.*
- *Describe how biologists learn about animal behavior through radio-telemetry work.*
- *Analyze the difficulties of trying to breed wild animals in captivity.*
- *Describe the federal Endangered Species Act and evaluate the protections it gives to vulnerable species.*
- *Analyze the relationship between predator and prey.*

PROGRAM SUMMARY

In 1972 biologists recorded the disappearance of the last known colony of black-footed ferrets, members of the weasel family that live in prairie dog towns and feed on the prairie dogs. When no more ferrets were found during the next decade, scientists increasingly came to believe that the ferret was extinct. Then, in 1981, a ferret colony was discovered in a prairie dog town near Meeteetse, Wyoming. State and federal biologists quickly converged on the site and began extensive studies on the only known surviving black-footed ferrets.

The black-footed ferret probably was never very numerous. Its existence was first reported in 1851 by John James Audubon, the Nineteenth Century naturalist famous for his paintings of birds. No further specimens were found for a quarter of a century, prompting some of Audubon's contemporaries to think for a time that he had been mistaken in his identification of the new species.

Black-footed ferrets once ranged from southern Alberta and Saskatchewan south through the plains into Texas. They lived exclusively in prairie dog towns, some of which covered hundreds of square miles. Weighing two or three pounds and growing to no more than two feet in length, the ferret was a nocturnal predator that specialized in feeding upon prairie dogs, burrowing rodents nearly its size. As settlers flowed into the plains, they attempted to eradicate prairie dogs because the rodents competed with livestock for grass and because their far-flung burrows were a hazard to hoofed animals. The federal government even today carries on extensive prairie dog poisoning programs. Killing off the prairie dogs eliminated not only the ferret's primary food source, but also its source of shelter, the prairie dog burrows.

In addition, government predator control programs designed to kill off wolves and coyotes probably also killed ferrets among many other nontarget species. Today the black-footed ferret is one of the rarest mammals in

the world and is on the federal list of endangered species. Its rediscovery in Wyoming in 1981 was a biological sensation.

Biologists studied the Meeteetse ferrets by trapping the animals and radio collaring them. This allowed the biologists to follow the ferrets on their nightly rounds, learning about their predatory patterns, range, territoriality, rearing of young, use of habitat, and other behaviors. The biologists also studied other animals that use the same habitat, such as the badger. Study of the badger was critical because badgers—large burrowing weasels—may prey upon ferrets.

From 1981 to 1984 the number of known ferrets grew rapidly. In 1984, at the population's peak, some 130 ferrets were known to inhabit the sixty-square-mile prairie dog town near Meeteetse. But tragedy struck in 1985 after large numbers of prairie dogs succumbed to sylvatic plague, a disease carried by fleas. Fearing that loss of the prairie dogs would doom the ferrets, biologists had the town sprayed with an insecticide deadly to fleas but harmless to ferrets. Shortly after this, the ferrets began to die off. They were being killed by canine distemper, a viral disease that affects dogs, wolves, coyotes, and other animals. Some biologists speculate that the distemper was brought in by people working in the area, perhaps by the men who applied the insecticide. It also may have been transmitted by other wild animals, such as raccoons. Within months, barely two dozen ferrets survived. Biologists immediately moved to capture all remaining ferrets. Nearly twenty were found and placed in a Wyoming Game and Fish Department facility for captive breeding. The future of the black-footed ferret lies in successfully breeding these animals in captivity.

BACKGROUND MATERIAL

The last of the known wild ferrets was taken into captivity in February 1987. Early the following June, that ferret fathered two male and four female pups, the first ever born in captivity. Two more ferrets were born to another female at the end of June. One of them died, but success in rearing the others brings hope for a successful recovery program.

All of the ferrets are being held at the Wyoming Game and Fish Department's Sybille captive-breeding facility near Wheatland. The state plans to build at Sybille a miniature prairie dog colony in which captive-born ferrets can learn to hunt properly. This is part of a plan to release ferrets to the wild once two hundred breeding pairs are held in captivity.

The recovery effort is not focused entirely on captive breeding. Ferret biologists are also seeking to locate other ferret populations. The New York Zoological Society is offering a reward to anyone who finds more black-footed ferrets in the wild.

One of the animals that wild ferrets may encounter is the badger, a member of the weasel family and an avid burrower. It may dig a new burrow every day. It is well adapted for digging—its front claws are long and curved, its muscular body short and flattened. It feeds on mice, ground squirrels, insects rabbits, virtually anything it can catch. This, as pointed out in the program, makes it a hazard to black-footed ferrets. The badger grows to nearly three feet long and twenty-five pounds. It has a reputation for viciousness, primarily because if attacked it will back into a burrow and defend itself vigorously.

The primary food of wild ferrets is the prairie dog. These rotund little animals got their name from a peculiar barking noise they make when warning one another of danger. Prairie dogs, denizens of the western plains, are rodents, relatives of ground squirrels, mice, and rats. They live in colonies called towns. Large towns are divided into discreet social subunits. All the prairie dogs within a single subunit know one another and defend their section of town from prairie dogs that live in other subunits.

A century ago especially large prairie dog towns stretched for up to two hundred and fifty miles long and a hundred miles wide and housed perhaps 400 million prairie dogs. By riddling such extensive areas with their burrows, the prairie dogs helped churn the soils, mixing in nutrients and enriching the grasslands. Their burrows were and still are important to other prairie wildlife. Rattlesnakes use their dens. Salamanders and toads, amphibians that need cool moist areas for survival, find summer refuges in the burrows. The burrowing owl, a small species hardly bigger than a robin, lives in the colonies, too, although the owls are increasingly rare.

PRE-VIEWING ACTIVITIES

Assign reading of the background material. Feel free to photocopy. Discuss the concept of **endangered species** and why the black-footed ferret classifies as such. Why do environmentalists care about endangered species like the black-footed ferret?

DISCUSSION QUESTIONS

Many of the following questions lack definitive answers. They are meant to stimulate discussion about the black-footed ferret and investigation into the problems that confront endangered species.

1. What does the ferret biologist in the program say are the distinctive signs that indicate whether black-footed ferrets are present in a prairie dog town?

2. The narrator says that as Americans moved west they turned hundreds of thousands of acres of prairie into farms. For example, in Illinois 99 percent of the original prairie has been plowed for agriculture. As they settled the West, farmers and ranchers poisoned whole prairie dog towns because they thought the prairie dogs competed with livestock for food. Were the farmers and ranchers right about the prairie dogs? Hint: Research indicates that prairie dogs eat many grasses that livestock ignore; also, the prairie dogs' digging helps rejuvenate soil by mixing in nutrients. Could big prairie dog towns have co-existed with large-scale farming? If you thought you had to choose between having prairie dogs and growing crops, which would you choose? Hint: Currently, many crops are grown in surplus. Do you think we can afford to give back to the prairie dog some of the land used for surplus crops? What problems would arise from trying to do that?

3. The program shows biologists trapping and radio collaring ferrets in the wild. Was handling of the ferrets good or bad? What does the program say may have happened because of such activities? Hint: More than one hundred ferrets were killed by distemper that may have been brought in by humans working in ferret habitat, and all surviving ferrets were taken into captivity. No black-footed ferrets remain in the wild. Is it possible that the ferrets might have died off even without human interference? Did what was learned about the ferret make the risk of entering their habitat worthwhile?

4. We learn from the program that the pronghorn, an antelope-like animal of the plains, nearly became extinct toward the end of the Nineteenth Century. As a species that people hunt and eat, the pronghorn in this century has been carefully protected and its numbers have increased dramatically. How does this compare with the fate of the black-footed ferret, which is not a hunted species? How does the work being done on the ferret compare with human interest in protecting less appealing creatures and plants? Should we worry about the survival of rare plants, or small fish, or snails, or clams? Why? Why not? Hint: A grass species may be food for a prairie dog that is food for the black-footed ferret. Nevertheless, it is true that the bulk of endangered species work is devoted to big, appealing animals, while smaller, less attractive creatures are largely ignored. For example, invertebrates are only a small percentage of the species on the federal endangered species list. What does this suggest about the protections given by the Endangered Species Act?

5. Biologists are studying the behavior of the badger to see how it interacts with the black-footed ferret. In what ways can the badger's behavior have anything to do with the survival of the ferret? Hint: Badgers may eat ferrets; badgers eat prairie dogs, thus competing with ferrets for food.

6. Biologists say that all living things are interrelated, that the survival of one species may be important to another. In what ways does the ferret program illustrate that this is true? Hint: The prairie dog may be food for snakes, hawks, badgers, weasels, ferrets, burrowing owls; prairie dog burrows provide homes for snakes, ferrets, burrowing owls, amphibians, and other animals; the prairie dog's burrowing behavior enriches the soil, providing better forage for grazers such as pronghorns; prairie dog activity flushes insects out of the grass, making them easier prey for insectivorous birds.

7. The narrator indicates that the owners of the ranch on which the black-footed ferrets were found have a "history of understanding that there is a correlation between healthy habitat, healthy wildlife populations, and healthy cattle production." In what ways have unhealthy wildlife conditions warned humanity of impending problems? Hint: In Green Bay, Wisconsin, cormorants and other shorebirds are showing unusually high levels of birth defects, apparently because of toxins in the water and in the fish the birds eat. The rate of human miscarriages in the area also exceeds the national average. The decline of the bald eagle, peregrine falcon, and osprey through the 1940s, 1950s, and 1960s because of contamination by the insecticide DDT opened the door to concern for human health and stimulated the creation of better laws for the control of chemical use.

8. In the program, biologist Louise Forrest says that saving the ferret is not going to affect how people breathe or the quality of the water they drink. But, she says, how people deal with the ferret "is symptomatic of our ethic on dealing with natural resources." Are ethics an important consideration in human conduct toward natural resources? What does preservation or destruction of the black-footed ferret and other jeopardized species suggest about the people who are attempting to preserve them and about those whose actions destroy them?

9. Badgers occasionally kill black-footed ferrets. How do you feel about the badgers? Should they be killed off in areas where ferrets survive in order to protect the ferrets? Is it right to kill one animal to save another?

10. A contagious disease nearly wiped out the black-footed ferret population, which numbered some 120 animals. Would more ferrets have survived had there been two hundred of them? Three hundred? If two separate populations had existed, would the ferret's chances of survival as a species have been better? If there were three populations? Hint: A species that exists as a single population, especially a small population, is always in jeopardy since it can be wiped out by a disease or other catastrophe. To prevent this, new populations of rare animals are sometimes created artificially, as in the case of the California condor and the sea otter.

11. What biological factors make black-footed ferret survival difficult in the modern world? Hint: Compare the ferret and the badger. Both are types of weasels, but the badger eats a wide variety of foods. If the prairie dogs it sometimes preys upon were wiped out, it could eat other foods. The ferret eats mainly prairie dogs and lives almost exclusively in prairie dog towns. It is more specialized than the badger, and specialized animals, those that require specific types of food or breeding places or other biological needs, are highly vulnerable to extinction. Why? Can you think of other highly specialized animals that also face extinction? Hint: In the wild the giant panda eats virtually nothing but bamboo.

FOLLOW-UP ACTIVITIES

1. Have the class "adopt"an endangered species and follow closely any news on its protection and management. Some students should report regularly to the class on any new developments.

2. Invite a speaker from the state nongame program to discuss local endangered species with your class and to tell how the state is protecting them.

3. Have a group of students prepare a class report on your state list of endangered species. Have them find out why the species are declining and what is being done to help them.

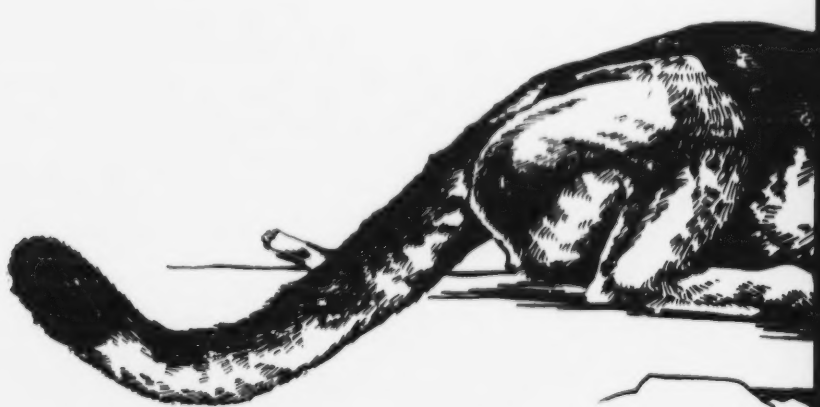
4. The class can pretend that it is the black-footed ferret recovery team. Assign each student an appropriate role, such as rancher, biologist, game department researcher, and so on. The students should research the views of the people they represent before presenting the class with their arguments on ferret recovery.

5. Invite a speaker from the local zoo to discuss the problems of captive breeding. Ask your students to discuss how the speaker's comments relate to the black-footed ferret.

6. Select a species from your state list of rare, endangered, or threatened species. Appoint a class recovery team for the species. The students should learn all they can about the species survival problems and needs and create a plan for its protection and recovery. This project could take most of the school year and perhaps even produce useful information for the state wildlife agency. You can get samples of recovery plans to use as models by contacting the U.S. Fish and Wildlife Service's Office of Endangered Species or by requesting one from your Senator or representative in Congress.

7. Urge students to work as volunteers for the local wildlife agency, Audubon chapter, or local nature center, preferably in a program that focuses on endangered species. Have them report to the class regularly on their activities. (See resource section for more information)

8. Divide the class into two groups to debate the advantages and disadvantages of a captive-breeding program. Adversaries may claim that captive breeding, particularly when no animals of the group are left in the wild, leads to genetic weakening. This is caused by **inbreeding** and the removal of all natural selection factors. They should also consider whether it would be better to protect the few remaining animals in their natural environment.



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On the Edge of Extinction: Panthers and Cheetahs

After viewing the program and participating in the activities suggested here, your students will be able to:

- *Compare the survival problems of a variety of declining species, including the cheetah, Florida panther, African rhinoceros, and African elephant.*
- *Analyze the conflicts that have arisen between humans and wildlife.*
- *Evaluate how human population growth is causing destruction of wildlife.*
- *Analyze the ways in which loss of wildlife habitat to human encroachment causes species to decline.*
- *Analyze the difficulties of trying to breed wild animals in captivity.*
- *Explain how diseases limit wildlife populations.*

PROGRAM SUMMARY

Wildlife **habitat** is being destroyed throughout the world by human development. This National Audubon Society Special examines several species that are being affected by this destruction. It begins with the cheetah, a large member of the cat family that once roamed over much of the Earth, including Africa and Asia. Today, viable populations are restricted largely to Africa. Those that survive are faced with extinction because of human encroachment on their habitat.

This apparently is not the first time the cheetah has faced extinction. Some ten thousand years ago, during the last ice age, it nearly vanished. The limited number of cheetahs that remained became inbred. The result is that cheetahs today are much alike genetically and have little reproductive vigor. Nevertheless, the doom that cheetahs face today is largely human caused, part of a vast wave of human-caused extinctions that in the next few decades may destroy twenty percent of all species. This dramatic loss differs from the natural process in which disappearing species are replaced by newly evolved varieties so that the number of species alive at any one time increases.

To try to protect the species that exist right now, conservationists are urging the governments of their own and other nations to set aside wild habitat so that wildlife will have a place to live. Conservationists also are attempting to breed animals in captivity as a second line of defense against extinction.

One example of the massive efforts undertaken to protect wildlife is the work that focuses on the Florida panther. Perhaps no more than thirty of these animals, a subspecies of mountain lion, survive. Biologists are using **radio telemetry** to learn about their movements and how they use their habitat. This information will help in the development of programs for panther protection. Biologists also are vaccinating the cats against disease in an attempt to prevent early deaths. But the main problem for the Florida panther is loss of habitat. These animals need a lot of land to survive. An adult male needs up to four hundred square miles.

The panther today lives deep in the swamps that provided the cat with its last refuge as development overwhelmed its habitat early in this century. In the past, people had little use for the swamps, but today even those fragmented areas are being drained for agriculture and other uses. The panther has retreated as far as it can go. Biologists are concerned that what little land remains for the panthers is not providing them with enough food. In the program, biologist Melody Roelke says the panthers need large prey species such as deer and hogs. But research shows they are feeding on smaller animals. "A lot of the adult females we're catching," she says, "are underweight, they're anemic, they're not healthy, vibrant animals." In addition, the panthers are inbred, causing disease, parasitism, infertility, and low survival of offspring. Efforts are being made to protect more habitat for the panther and to breed the animals in captivity.

BACKGROUND MATERIAL

A member of the cat family, the cheetah is the fastest land mammal. When chasing its antelope prey it can reach sixty miles per hour for short distances. They are the only member of the cat family that lacks retractable claws. Their feet resemble those of a dog. Royalty in India made pets of them and used them for hunting game. Loss of habitat and problems with infertility and inbreeding are causing cheetah numbers to dwindle.

Similar problems are faced by the Florida panther, the last of the eastern mountain lions. Mountain lions once ranged throughout most of the area now called the United States. Early colonists killed them relentlessly. Today mountain lions survive mainly in the mountains of the West, from British Columbia south into Patagonia. They are protected in most western states. In California, they have increased in recent years. Only in Texas are they still hunted without protections. The Florida panther is the only mountain lion subspecies to survive in the East. It is a true remnant of pristine America. About thirty of them remain in South Florida.

The dart gun used to subdue a Florida panther in the program shoots a metal syringe that injects its target on contact with a sleep-inducing drug. Use of dart guns and drugs on wild animals is very risky. The darts usually are good only at short range and hit with a hard impact. If fired into a part of an animal that lacks heavy muscular cover, the darts can break bones or cause other internal injuries. Estimating how much drug to use is also difficult. Each species has its own drug tolerances, and within a single species how much drug to use depends on the weight of the animal. The program suggests how easy it is for even experts to guess the weight wrongly. Wrong guesses can lead to overdosing. Also, some drugs disrupt an animal's ability to regulate its body temperature. If an animal is hot from being chased, it can easily overheat and die while under the effects of a drug. Despite these shortcomings, dart guns have made radio collaring a standard technique with many species for which it would otherwise be impossible.

Captive-breeding programs that may benefit animals such as the cheetah and Florida panther are being conducted by zoos. The program illustrates how some rare antelope are being bred in captivity by implantation of their embryos in more common antelope species. One antelope discussed in the program is the bongo, a native of the cool, misty forests of the mountainous portions of central Africa, from Sierra Leone to Kenya. Adults weigh about 450 pounds. Both males and females have horns. Bongos travel in family groups of up to twenty individuals, but usually do not form large herds. The eland also appears in the program. Weighing nearly a ton when fully grown, the eland is the world's largest antelope. Elands once lived in herds of a few to more than a hundred individuals in central and southern Africa, but have vanished from a large portion of the range because of over hunting. The species is listed by the federal government as endangered.

The nilgai, a large antelope of peninsular India, has not yet been threatened with extinction. The largest antelope native to India, the nilgai stands about five feet tall and weighs about 400 pounds. Males have short horns, and so have never been much sought by hunters. Hindus believe they are closely related to the sacred cow, and so do not harm them. Females live in herds with calves, old males are usually solitary.

Captive-breeding programs bring their own difficulties. Because captive breeding usually relies on small numbers of animals, offspring soon show the deleterious effects of **inbreeding** already seen in the wild panther and cheetah, including increased susceptibility to disease. Zoos are trying to increase captive populations through surrogate motherhood. The program explains how embryos are taken from rare antelope, such as the African bongo, and placed for development in more common antelope species, such as the eland. This helps boost production of rare species.

Zoos are interested in captive breeding because they hope one day to use their animals to revive species depleted in the wild. This hope has become something of a reality for at least one species of primate, the golden lion tamarin. Tamarins bred at the National Zoo in Washington, D.C., have been released into wild habitat in Brazil, where only 150 of the little monkey-like creatures remain. As a result, the wild population has doubled.

Despite the success of the tamarin captive-breeding program, captive breeding, says biologist E.O. Wilson, is a last resort for protecting vanishing species. The best conservation technique is protection of habitat, Wilson says.

Governments throughout the world are trying to protect habitat, but have found it hard to do. This program reveals how human encroachment is gradually destroying Kenya's Masai Mara game preserve, a small area essential to wildlife during the dry season. Moreover, as wildlife is increasingly restricted to preserves, populations begin to outgrow the land left them. In some cases, wildlife managers kill off certain numbers of animals, such as elephants, to keep them from destroying the land they and other animals need for food.

Despite the difficulties, protection of wildlife is thought vital by biologists. Many human medicines come from wild plants, as do many human foods. The species lost to the coming wave of extinctions may include plants and animals that would provide undiscovered cures for disease or new forms of food. The program concludes, "Efforts to protect natural habitats and the species that depend on them for survival can succeed. There is still time to prevent one of the worst tragedies in the history of man and Earth—extinction."

The last of the antelope that appear in the program is the wildebeest. Also known as the gnu, the wildebeest lives in the plains of Africa, from Kenya and Tanganyika south. The wildebeest lives in herds of five to fifteen animals led by a male. Occasionally they gather into herds of more than a hundred individuals. The tail of the wildebeest is used as a fly swatter called a chowrie, a symbol of rank in some parts of Africa, which has caused its numbers to be reduced by excessive hunting. However, a good number still survive in East Africa.

Some antelope populations have been decimated by rinderpest. A deadly disease of ruminants, rinderpest was spread by cattle from Asia or eastern Europe into Africa in the late Nineteenth Century. Caused by a virus, its symptoms include fever, diarrhea, and dehydration.

One animal that has benefited recently from captive breeding programs is the golden lion tamarin. A small primate of eastern Brazilian rainforests, the golden lion tamarin has lost most of its habitat to clearcutting and is federally listed as endangered. Captive-reared tamarins have been successfully reintroduced into the wild in parts of the species' range. Wild tamarins travel in small groups, seeking shelter in hollow trees. Males help with the rearing of the young.

PRE-VIEWING ACTIVITIES

Ask students to list the ways animal (birds, rabbits, squirrels) populations in their own areas are affected by human habitation. Hint: Food supplies, traffic, places to nest. Discuss reasons for caring about the effect humans have on wildlife survival.

DISCUSSION QUESTIONS

Many of the following questions lack definitive answers. They are meant to stimulate discussion about the problems that confront endangered species.

1. On the *Edge of Extinction* suggests that the human population is exploding. What is this explosion doing to the cheetah? The Florida panther?

2. How is population growth affecting wildlife habitat in your own area?

3. From the program we learn that the Florida panther was hunted mercilessly until the 1950s, when it was finally given protection under state law. By then the last survivors lived deep in swamps for which man had little use. What does this suggest will be the fate of animals that live in areas useful to man? Do you think the panther would have been given protection in 1950 if it had still been in conflict with human goals?

4. The program suggests that human hunters in some areas may be competing with Florida panthers for the deer upon which the panther relies for food. Which hunter do you think is better equipped to win this competition, human or panther? What changes can be made to help the panther? If you have to choose between supplying deer for humans who hunt for fun or panthers who hunt for food, which would you choose? Do you think anyone would disagree with your choice? What would their arguments be?

5. The narrator says, "Zoos have long known that captivity itself can make breeding wild animals difficult." What difficulties encountered in the captive breeding of cheetahs are outlined in the program? What do these difficulties suggest about the chances for survival of other species that exist only in small numbers? Most efforts to protect wildlife do not begin until species are at low population levels, compounding recovery efforts with the problems of inbreeding. What alternative approach to the protection of species would you suggest?

6. Cincinnati Zoo physiologist Betsy Dresser says, "I think we as people of this world have to realize what we are doing as we destroy our habitats." Discuss what habitat destruction is doing to the species seen in the program. What could be done to avoid this destruction?

7. The program illustrates how zoos are carefully breeding animals in preparation for the day when the animals will be used to "revive species that are depleted in the wild." If the animals are depleted because of habitat loss, do you think it will be possible to release these animals in the future? Where would they be released? Do you think breeding in captivity will have affected the animals in any way? Will they have lost some of the survival skills they need in the wild? How realistic is the goal of releasing captive-bred animals if habitat is not protected?

8. Discuss how the decimation of wildebeests by rinderpest from domestic cattle disrupted the Serengeti-Mara ecosystem. What does this suggest about the interrelationship of the organisms that live within a single ecosystem? What does this suggest about the chances for success of efforts to protect isolated fragments of wilderness?

9. A Masai in the program said that the world is growing smaller. "Whatever land people had a long time ago, they don't have as much today," he said. 'When I say small, it's because what you can see here, this is my land here, this is all I have." Why has this man's land shrunk? Compare what is happening to him with what is happening to Africa's wildlife. How are the needs of humans and wildlife similar? Who is taking away the land?

10. Some people suggest that wildlife preserves should be fenced to protect them. How would this affect migratory animals such as the wildebeest? How would this affect plant life on the preserves? If animals were carefully protected within fenced preserves, what would happen as their numbers increased? What alternative protections can you propose?

11. Discuss the role of technology in determining the fate of wildlife. Is it good or bad? Hint: Technology in the form of radio telemetry is helping biologists learn more than ever before about various species and is providing keys to better captive breeding programs; technology in the form of better roads, weapons, and building equipment is permitting greater inroads on wildlife and giving poachers better access to animals.

12. The narrator said that the panther's survival depends more than ever on public tolerance. This is true too of many other animals, including the cheetah and rhino. What is public tolerance? What kind of behavior does it imply? How tolerant do you think the public is likely to be? What will compel public tolerance?

13. Tourism is increasing in Africa. Is tourism another form of human encroachment on wildlife? Is it good or bad? How can tourism be handled for the benefit of wildlife?

FOLLOW-UP ACTIVITIES

1. Have students prepare charts or maps that show where human populations are increasing and the rates at which the increase is occurring. Have them select the five fastest places on their maps and prepare reports on how population growth in those areas is affecting wildlife. Information can be obtained from such organizations as Zero Population Growth, Inc., 1601 Connecticut Avenue NW, Washington, DC 20009 and the National Audubon Society, 950 Third Avenue, New York, NY 10022. Also assign students to prepare reports that show how fast the world population is growing, where it is growing fastest, what effect population growth is having on wildlife on various continents, what experts are predicting about population growth in the near future, what can be done to stem human population growth.

2. The program suggests that "overpopulation, unwise use of natural resources, and widespread poverty are consuming and fragmenting the natural world." Have students prepare reports on how fragmentation of the natural world is occurring in tropical Central and South America and in Asia. Reports can be prepared on such topics as why the tropical rainforests are being cut, how the cutting is affecting wildlife, who is paying the bills for the various deforestation projects, and what can be done to stop them.

3. Have students compare the rate of natural extinctions with the rate of human-caused extinctions. For example, have students investigate the extinction of the dinosaurs and compare it to the extinctions expected as a result of tropical deforestation. Find out what problems might arise as a result of the current extinction rate.

4. The program indicates that the Masai Mara wildlife preserve "is a tiny remnant, and, like most other reserves, it is more vulnerable than ever to the forces of change—both natural and man-made—as it becomes isolated in a vast sea of humanity." Have students investigate the problem of fragmented habitat further by assigning them reports on the problems that isolation has created for mountain gorillas, Javan rhinos, and Asian and African elephants. Have them examine the isolation problem in the United States by preparing reports on how isolation is affecting national parks and wilderness areas and the management of species such as the grizzly bear, gray wolf, Florida panther, and, in Yellowstone National Park, the elk.

5. The program outlines briefly the problems of managing African elephants on increasingly smaller plots of land. Elephant management can illuminate the many problems involved with protecting wildlife in preserves. Have students prepare reports on elephant protection.

Assign different students to report on the social life of elephants, elephant habitat needs, the importance of elephants to other animals, how elephants change their habitat, and what is being done to limit elephant numbers. Have a student prepare graphs showing the decline in elephant habitat and elephant populations. Have the students discuss how they feel about the choices that wildlife managers sometimes have to make.

6. Invite a local official from the state wildlife department to speak about state programs designed to preserve habitat for wildlife, such as state wildlife refuges, game management areas, and farmlands protected for wildlife.

7. Have students select ten plants and animals from the federal endangered species list and learn more about their distribution, numbers, and survival problems. Have them prepare a table that compares the ten listed species to species that are surviving in good numbers. Have the table show whether the listed and unlisted species are large or small plants or animals, widespread or of limited distribution, herbivores or predators, economically valuable or lacking in value, found on valuable lands or on lands lacking in value, island residents or continental residents. What differences exist between species that fail to survive and those that succeed? Can your students determine what types of species, as a rule, are most likely to be vulnerable to extinction in a human-dominated world?

8. Have a student or group of students "adopt"an endangered species by following closely any news on its management and protection. Have some students report regularly about what is happening to the species.

9. Invite a speaker from the state nongame program to discuss endangered species with your class and explain what the state is doing to protect them. Or invite a speaker from your local Audubon Society chapter. (See Resource section—National Audubon Society)

10. Ask a student or a group of students to prepare a class report on your state list of rare or endangered species. Have the students find out why the listed species are declining and what is being done to help them.

11. Invite a speaker from the local zoo to discuss the zoo's captive breeding programs. Have the class review the difficulties of inbreeding outlined in the program and ask the zoo representative what zoos are doing to overcome them.

12. Pick a state-listed endangered species and, using the class as a recovery team, make a recovery plan for the species. This project would involve investigating the species' survival problems, costs of recovery, sources of funds, and so on. This project could take all year to complete and could make a real contribution to local conservation work. You can get samples of recovery plans to use as models by contacting the U.S. Fish and Wildlife Service's Office of Endangered Species or by requesting one from your senator or representative in Congress.

13. Find out about the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), signed in Washington, D.C., in 1973. As of 1986, 92 nations had joined the convention. Have accelerated students prepare a report comparing CITES with an international law or trade act. The report should answer these questions: What effect has CITES had on protecting endangered species? Are there other similar, signed agreements among nations? Hint: Yes, on migratory species and whaling, for example.

14. Divide the class into two groups for a debate on the advantages and disadvantages of a captive-breeding program. Adversaries may claim that captive breeding, particularly when no animals of the group are left in the wild, leads to genetic weakening. This is caused by inbreeding and the removal of all natural-selection factors. Some may argue that it would be better to protect the few remaining animals in their natural environment.

15. Accelerated students can study a special high school level activity on the cheetah developed for the monograph, "Immunology and Human Health"and distributed free in 1986 to all high school teachers who belonged to the National Association of Biology Teachers. "Activity for the Cheetah—A Potentially Extinct Species?" focuses on the interactions among genetics, immunology, and evolution. Student and teacher notes are provided for studying natural extinction due to low genetic variation in the cheetah. (See Resource section—National Association of Biology Teachers)

16. Divide the class into six groups. Assign one group to write a brief natural history of the cheetah, including a description of the animal and information on what it eats, how it hunts, when it mates, what kind of habitat it needs, and what its daily activities are. Assign a second group to report on the decline of the cheetah. The report should include a comparison of the cheetah's range approximately a century ago with its present range and information on reproductive problems revealed by research on cheetahs in zoos. Assign the third group to report on the problems cheetahs face in the wild, the causes of cheetah decline, and the efforts being made to save them. Assign the other three groups of students to do the same thing with the Florida panther. Have each group report to the class on what it has discovered. Allow the students at least two weeks to complete their assignments in the event that they need to write to the **U.S. Fish and Wildlife Service** or the **Florida Game and Fresh Water Fish Commission** for information.

17. Photocopy the map of the United States included in the guide. Provide each student with a copy of the map. Have them show on the map the extent of the cougar's range before colonization of the United States and the extent of its range now.

Ducks Under Siege

After viewing the program and participating in the activities suggested here, your students will be able to:

- *Analyze how wildlife survival is critically linked to the health of the environment.*
- *Describe how fees paid by hunters help fund wildlife management.*
- *Evaluate how wildlife species can warn of impending human health problems.*
- *Define and identify a wetland.*
- *Evaluate the importance of wetlands to wildlife and people.*

PROGRAM SUMMARY

The fate of waterfowl is closely linked to the integrity of the land on which the birds depend for survival. Consequently, as waterfowl expert Frank Bellrose says in *Ducks Under Siege*, "Birds are an index to the health of the land." Currently, the index suggests that the land is in trouble. Mallard numbers in 1985 were half of what they were in 1955. Blue-winged teal are down forty-one percent, and pintails sixty-nine percent.

Waterfowl populations have been declining in recent years because their wetland breeding and feeding areas in the United States and Canada are being lost to development. *Ducks Under Siege* illustrates what is happening to waterfowl and wetlands in several specific areas in North America. These are:

California. Some twelve million ducks and geese winter in California's Central Valley, comprising about ninety percent of the waterfowl in the Pacific Flyway. The Central Valley is extremely important to the survival of those birds. But more than ninety percent of the wetlands that attract the birds to the valley have been drained for flood control and agriculture. Pacific Flyway waterfowl have had to squeeze themselves into increasingly smaller and smaller wetlands areas. Even on national wildlife refuges established specifically for waterfowl protection, wetlands exist at the whim of agriculture. The water that fills many refuge marshes is agricultural drain water. Since 1983, the hazard this poses to waterfowl and other wildlife dependent on the refuges has become increasingly clear. The agricultural runoff contains toxins leached from the farm soils. The toxins become concentrated on the refuges, where they are causing birth defects among the waterfowl. To prevent this, the federal **Bureau of Reclamation** has forbidden farmers to run drain water into refuges where toxins have accumulated. However, political pressures favoring agriculture make the future of the refuges uncertain.

Louisiana. In twenty years, Louisiana has lost three quarters of a million acres of the Mississippi Delta marshes that nature took centuries to build. The marshes are being choked off by flood control levees and killed by salt water rushing in from the Gulf of Mexico through canals cut for oil exploration and shipping. Some laws have been passed to stem the loss, but fifty square miles of wetlands are still being lost yearly in the delta, changing marshes valuable for waterfowl into open water where the birds cannot survive. Says one local resident in the program, "There's been less duck and less duck every year. And there's still less duck."

Breeding Grounds. Waterfowl breeding grounds extend from south-central Canada to the north-central United States. They are characterized by the myriad small ponds, called potholes, on which the ducks breed. But the numbers of these ponds are dwindling as farmers have drained them and plowed the tall grass that waterfowl use as camouflage from predators. North and South Dakota have lost more than half their potholes since the 1950s. Because the United States according to the program, cannot undo the damage, the only hope is in Canada. But even there farmers are destroying the wetlands to grow more crops. As a result, waterfowl must nest on smaller territories, making them more vulnerable to the predators that wipe out ninety percent of the nests in some areas. The future for waterfowl lies now in Canadian educational programs that promote better conservation among farmers and in federal programs in the United States designed to make public lands more appealing and safer for nesting waterfowl.

Ducks Under Siege also touches upon a major conservation irony. The bulk of waterfowl protection is funded by federal dollars earned by the sale of federal duck stamps, required of all waterfowl hunters. However, as ducks and geese crowd into smaller and smaller areas, they fall easier prey to hunters. The federal government may one day need to restrict hunting, but the restrictions would cause a drop in the funds from duck-stamp sales.

The program also shows how urban growth around San Francisco Bay and in New Jersey is threatening the few remaining fragments of coastal wetlands in those areas. In California, conservationists are banding with waterfowl hunters to try to prevent wetlands destruction by developers. In New Jersey, the National Audubon Society helped a real estate developer create a housing-tract plan that takes waterfowl needs into consideration. Cooperative efforts such as these help both conservationists and developers to achieve their goals. "As we've seen in New Jersey," the narrator concludes, "it needn't be a given to sacrifice waterfowl and other wildlife in the name of progress . . . . There is still time to save the marsh, and save the ducks, for tomorrow."

BACKGROUND MATERIAL

As used by wildlife managers, the term waterfowl refers to the ducks and geese native to North America. Most of the species are hunted. The federal government determines how long the hunting seasons will be in each state, but the state wildlife agencies determine when in fall and winter the prescribed seasons will be held.

The U.S. Fish and Wildlife Service bases its waterfowl management on four natural migratory pathways that ducks and geese follow on their north-south migrations. These pathways are called flyways. State wildlife agencies have established four flyway councils to provide advice and cooperative assistance to the federal government in the management of waterfowl. The four flyways are the Atlantic, Mississippi, Central, and Pacific.

Waterfowl receive federal protection under a variety of migratory bird treaties. The Migratory Bird Treaty Act, passed by Congress in 1918, provided authority for implementing the first of these treaties, signed by the United States and by Great Britain on behalf of Canada in 1916 for the protection of birds that migrated between the United States and Canada. These species were at that time severely reduced by the professional hunters who supplied meat for markets. This bill marked the federal government's first major excursion into the realm of wildlife protection and in a sense was a precedent for all the federal wildlife legislation that has followed.

PRE-VIEWING ACTIVITIES

Ask students to define wetlands (see glossary for definition) and to determine if there are any wetlands in your county or state. If so, ask them to explain what they know about the wetlands and the animals that live there. Ask students if wetlands are important and give reasons why or why not.

DISCUSSION QUESTIONS

These are open ended questions that lack definitive answers. They are meant to stimulate discussion on the issues introduced by *Ducks Under Seige.*

1. Biologist Bill Sweeney states in the program, "Fish and wildlife are simply indicators of whether the environment is healthy or not, and when they lay there and die, something is wrong." What do the survival problems of ducks and geese suggest is wrong in the environment? Are any of these things likely to affect people? How? Hint: Toxins in the drainwater that for years poured into Kesterson National Wildlife Refuge in California are toxic to people as well as waterfowl; one disposal plan called for draining the water into San Francisco Bay, a source of drinking water for some communities.

2. *Ducks Under Seige* reveals that in California, the need to dispose of toxic agricultural run-off waters has pitted farmers against wildlife. One farmer says, "If people want to be fed and clothed, there's going to have to be some sacrifices." What sacrifices is he talking about? Are you willing to sacrifice thousands of waterfowl so that you can have food and clothing? What crops does the program suggest most California farmers are growing? Would you sacrifice waterfowl so that you can have these luxury items? Why? Why not?

3. In *Ducks Under Siege*, a farmer expresses the opinion that environmentalists who want to protect waterfowl may have to compromise on their goals because of the large amounts of money farmers have put into California's central valley and because of the many jobs that farming has created. Do you think that a large investment of money is a good reason to let waterfowl decline? Do you think the jobs these people have are worth more than waterfowl? Why? Do you think that the monetary investments justify the potential health problems created by agricultural pollution in the central valley? Do you think the pollution could affect the health of the people who depend upon agriculture for jobs? How? Is the choice really a matter of having just farms or just waterfowl? What other factors enter into the equation?

4. In the program, U.S. Fish and Wildlife Service biologist Bill Sweeney says that many service employees will not talk about water problems because they have been ordered not to discuss the issue. Who puts pressure on them not to talk? Hint: The orders come from within the Fish and Wildlife Service hierarchy; the program suggests that the pressure originates with politically powerful farmers. Why do you think that pressure is put on them? Do you think these experts should be allowed to tell the public about problems on federal wildlife refuges? Why? Do you see any potential threats to the public as a result of the stifling of information from federal agents? Might there be other reasons for not releasing this information?

5. *Ducks Under Siege* shows how the digging of canals by oil companies led to the destruction of Mississippi River Delta wetlands. Even the people who lived in the wetlands, depended upon them, and lament their passing, worked for the oil companies. Why do you think these people took those jobs? Do you think they would have taken the jobs if they could have known that twenty years later the wetlands would be gone? They were in fact told that the canals would wreck the wetlands. Why did they ignore the warnings? What does this suggest about the future of wetlands in other parts of the country where people are promised jobs by companies that ruin the land?

6. The director of the National Wetlands Research Center says that the Louisiana waterfowl that has lost its **habitat** to development will now have to find another home. If better lands were available, do you think these birds would have been in the vanishing Louisiana wetlands in the first place? If they are able to find new habitat, do you think it will be as good as the place they lost? How might the change affect the waterfowl?

7. Waterfowl, says *Ducks Under Siege*, are declining from widespread habitat loss and other problems. "Some experts fear that ducks are being overhunted," says the narrator. But because hunters are a strong political force, the Department of the Interior is reluctant to reduce hunting. What gives the hunters so much power? Hint: Hunters are required by law to purchase federal duck stamps if they want to hunt waterfowl. The funds raised from the sale of the stamps cover most of the costs of waterfowl management. Do you think that the payment of lawfully required fees justifies the hunters' political power? Why? Do you think that people other than hunters should help pay the waterfowl management bills? Why? How do you think waterfowl management would be affected if nonhunters helped fund waterfowl management?

8. In the program, a Canadian farmer talks about how he runs over nesting ducks with his machinery. He says the ducks will "just have to smarten up, I guess, and nest where we're not farming." Do you think the ducks will smarten up? Why or why not? Do you think the farmer could change his own habits during nesting season to protect the ducks?

9. In California, hunters discovered that the salt marsh harvest mouse, an endangered species, lived on a wetland slated for development. Because the Endangered Species Act forbids actions that harm endangered species, the hunters used the mouse to stop the development plans. Do you see any risks in this approach? Hint: In some cases in which environmentalists used the **Endangered Species Act** to stop development projects, Congress subsequently changed the law, weakening it so it could not be used that way again. What is the value of the law if Congress threatens to change it subsequent to controversial cases in which the law stopped development?

10. A Californian says of a wetland threatened by development, "...we were losing our club and I wasn't going to have a place to go anymore...it really opened my eyes—that nobody's going to have a place to go anymore to see a duck or just a morning like this.... Just a place to go and sit." Do people really need places where they can just go and sit? Do you have such a place? Is it important to you? What does this suggest about the protection of wetlands for wildlife? Will people benefit from the protection of wildlife habitat, too? How?

11. *Ducks Under Siege* illustrates how conservationists worked with a real estate developer to design a housing project good for both wildlife and people. The developer says, "What I've learned from this experience is to use what environmentalists are after as a marketing tool—that everyone today is interested in clean air and pure water, in quality of life items." Do you think the developers would have cooperated with the environmentalists if people did not care about the environment? Do you think the federal government would protect waterfowl if hunters were not interested in the birds? What do you think will happen to the natural world if people do not vocally support its protection.

FOLLOW-UP ACTIVITIES

1. The use of wetlands is governed by several federal agencies and laws. Have a group of students give a report on how the federal government administers wetlands and compare the approaches taken by different agencies. Ask the students to include a discussion of the affects these differences have on wetlands conservation and to evaluate the adequacy of federal wetlands protection. They should prepare their findings as a report for the class.

2. Invite a speaker from your state wildlife agency to discuss waterfowl management within your state. Before the speaker comes, have a group of students find out what problems waterfowl face in your state and what is being done to correct them. They should report these things to the class. Have the students develop a set of questions about the stability of funding levels for waterfowl management as the number of hunters declines and about alternative funding sources.

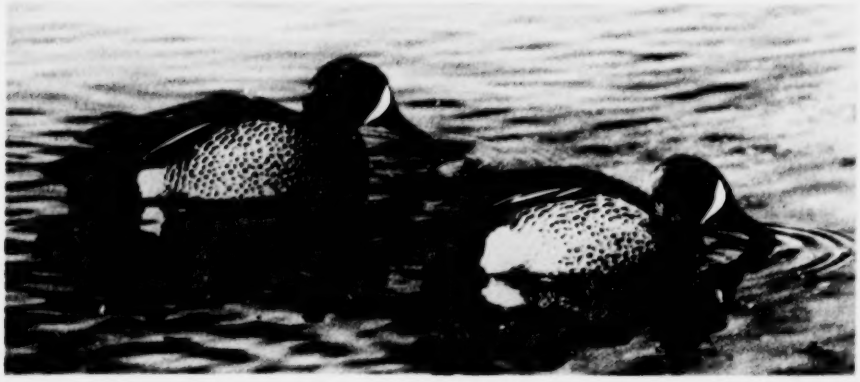
3. Arrange a class trip to a national or state wildlife refuge used by waterfowl. While visiting, ask your students to get answers to these questions What special management programs have been created for ducks and geese? Do these programs benefit other animals as well? Are these programs meant to correct problems elsewhere in the natural environment, such as lack of wetlands or natural food sources? What are these problems?

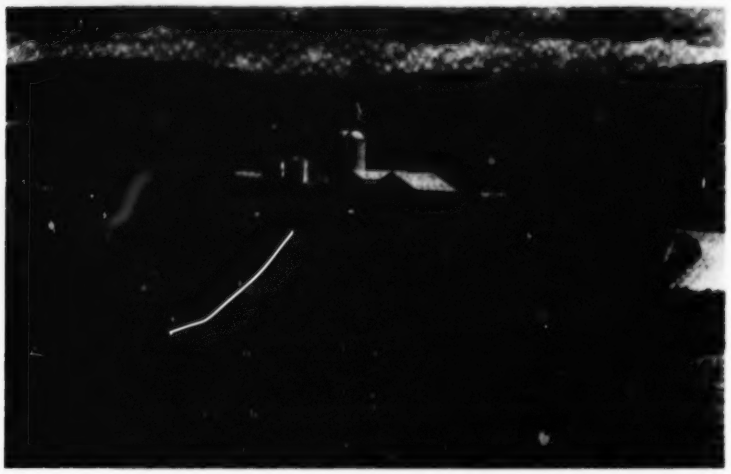
4. Wildlife protection by the federal government in many ways began with the protection of waterfowl in 1918. Have your students prepare reports on how waterfowl conservation helped enlarge the federal government's conservation mandate.

5. Invite an ornithologist from a local college or university to speak on the techniques and problems of migratory bird study. Ask the expert to address questions such as: Who is allowed to trap and band birds? How is permission granted? (You may also arrange for a speaker from your local Audubon Society chapter. See Resource section.)

6. Divide the class into three groups. Assign one group to write a brief natural history of waterfowl, including both ducks and geese. The report should include information on where waterfowl breed, when and how they migrate, and what type of habitat they need. Assign a second group to report on waterfowl management, including information on federal and state roles and on the trends in waterfowl numbers within each flyway. The U.S. Fish and Wildlife Service and your state wildlife agency can supply this information. Assign the third group to report on wetlands in the United States, including information on the extent of wetlands a century ago and today, the importance of wetlands to wildlife and water purity, and why wetlands are declining. Have each group report to the class on what it has discovered. It may be necessary for students to write to some of the agencies mentioned here, so give them at least two weeks to do their assignments.

7. Photocopy the map of the United States included in the guide. Provide each student with a copy of the map. Have them draw the flyways on the map and within each flyway note whether waterfowl populations are increasing or declining.





Common Ground: Farming and Wildlife

After viewing the program and participating in the activities suggested here, your students will be able to:

- ***Explain how the economics of farming affect land use and related environmental problems.***
- ***Describe how farming practices can have far-reaching environmental effects.***
- ***Evaluate the costs and benefits of highly mechanized farming and organic farming.***
- ***Analyze how farming activities affect the natural community.***
- ***Explain how biological processes influence agricultural success.***

PROGRAM SUMMARY

For the past fifty years, farmers and conservationists often have been at odds as farmers escalated use of pesticides and herbicides, creating hazards to both wildlife and human health. But that is changing. *Common Ground* illustrates how this change is coming about, how farmers are joining with conservationists in efforts to save soil, water, and wildlife.

Rising costs for chemicals and farm equipment coincident with a decline in farm profits are a major impetus for agricultural change. Changes in chemical use can benwfit both farmers and nonfarmers. Farmers have been going into debt to pay for chemicals that have filtered into the ground water and threatened human water supplies. For example, herbicides have polluted seventy percent of the drinking-water wells in Iowa. Chemicals used on fields in Pennsylvania have washed into rivers and found their way into Chesapeake Bay, where they have contributed to widespread die-offs of fish, notably the commercially valuable striped bass. Loss of the striped bass has caused disruptions in the economic lives of fishermen who depended on the bass for their livelihood. In Illinois, use of herbicides has reduced weeds so thoroughly in some fields that pheasant hatchlings can no longer find needed sustenance in the insects that normally infest weeds. In some areas of the state, pheasant numbers have dropped ninety-five percent in only twenty years.

These problems are being corrected as farmers change their use of chemicals. By using manure from cattle on his farm, one farmer shown in the program reduced his fertilizer bill sixty-five percent. Other farmers have learned that by better-planned rotating of crops, insect problems can be diminished without use of large amounts of insecticides. Techniques such as ridge tilling can help cut the loss of topsoil to wind erosion by fifty percent. The federal Agricultural Extension Service is showing farmers how to halve their fertilizer bills by ignoring the instructions of fertilizer manufacturers, who urge the use of large quantities of chemicals, in favor of well-planned fertilizer applications that use the chemicals more efficiently.

Some of the improved techniques that farmers are using result temporarily in lower crop yields. However, the crops are tastier and healthier than those grown by more conventional techniques. Moreover, production of these crops does not bring with it the environmental degradation of conventional, chemical-based agriculture. How widespread the use of environmentally safe agricultural techniques becomes depends in part on the consumer's willingness to pay higher prices for produce in return for a healthier environment and better foods.

Says the narrator in the conclusion of *Common Ground*, "Wildlife and farming have been thought, by conventional economic wisdom, to be at odds . . . . But today it's hard economic reality that is forcing farmers across the nation to take another look at their land and wonder whether in fact the only way to make a profit in the farming business is to include nature in the partnership."

BACKGROUND MATERIAL

Herbicides are poisons used to kill plants undesirable to farmers. Herbicides applied to farm fields can get into human water sources, where they pose risks to people.

Pesticides are poisons used to kill various plants and animals that cause economic losses, including molds, fungi, insects, and rodents. Many are toxic to a wide range of plants and animals, killing not only pests but beneficial species as well. Pesticides also have contaminated human food and water sources.

A 1987 study by the federal Department of Agriculture suggests that chemical-based agriculture increases erosion and therefore cannot be continued much longer. In the study, a field managed organically since 1908 was compared with a field subjected to chemical fertilizers and pesticides since 1948. The organically managed field has six inches more topsoil than the adjacent chemically farmed field. The difference in the two fields can be traced to the time when one of the farms converted to the use of chemicals. Researchers concluded that the topsoil on the chemical farm will be gone in 50 years.

PRE-VIEWING ACTIVITIES

Ask students which they think is most important, food supply or the environment? Are there conflicts between farmers and environmentalists? What is the source of the conflict? Ask students to propose resolutions to the conflict.

DISCUSSION QUESTIONS

Many of these questions lack definitive answers. They are meant to stimulate discussion of the issues introduced by *Common Ground.*

1. In *Common Ground,* farmer Dick Harter says that big equipment, leveling of land, and chemicals were all used to increase crop production. Did crop production increase on farms that used these tools? Did the production of anything else decline? Hint: Harter says that after a few years the fields became lifeless, a sort of biological desert. Later in the program the narrator states that wildlife habitat was lost, topsoil eroded away, and the water table became polluted with farm chemicals. Should increase in production be strictly a matter of increasing crop yields and monetary profits? What other factors should be considered?

2. *Common Ground* illustrates how farmers who once practiced highly mechanized farming techniques are flocking to Dick Thompson's workshops to learn about organic farming. Why are they now interested in organic techniques? Hint: Organic farming cuts costs in a time when farmers are dunned by debtors and crop prices are low. The program also points out that most farmers today are concerned with practicalities and costs. If the farming economy recovers, do you think these farmers will still be interested in organic farming? Why or why not?

3. In *Common Ground,* farmer Dick Thompson maintained a diverse money crop, including livestock, while other farmers tended to specialize by planting only corn and soybeans. How did specialization and generalization (maintaining crop diversity) in agriculture affect the fate of Thompson and the other farmers? Compare this to biological specialization and generalization (see glossary). What could farmers have learned by being aware of specialization and generalization in wildlife?

4. Farmer Paul Clugston says in *Common Ground* that he always relied on chemical manufacturers to tell him how much chemical fertilizer he should use on his fields. Analysis of his soil showed that as a result of following the manufacturers' advice he was using far too much fertilizer. Why would the manufacturer recommend the use of too much fertilizer? Where do you think the excess fertilizer went? Do you think asking a fertilizer manufacturer how much fertilizer to buy is a wise policy? Why or why not? How could Clugston have avoided this problem?

5. In *Common Ground* the narrator states that agriculture that conserves land resources and minimizes the use of chemicals can benefit not only the farmer but his neighbors, too. In what ways can this type of agriculture help a farmer's neighbors? What does this say about the far-reaching effects of a farmer's actions? What other human activities can you think of that also have far-reaching effects? What do such effects suggest about the social responsibilities of landowners?

6. How has the use of herbicides affected pheasants in Illinois? Hint: The herbicides killed off the weeds that harbored the insects on which pheasant chicks fed. Do you think anyone could have predicted this affect? Do you think other problems, equally hard to predict, could result from the use of chemicals? Do these potentially dangerous chemicals have any beneficial effects that justify their use? What do the potential hazards suggest about the use of persistent chemicals in the environment?

7. The program points out that young Illinois pheasants that have lost their food source to farming can go to fields that still provide food. But what hazard do the birds face in getting to better fields? Hint: The narrator says, "For a bird too young to fly, it's a dangerous journey to a good source of food." What does this problem suggest about wildlife's need for a proper arrangement of feeding, watering, and nesting sites? Is it enough simply to provide wildlife with protected areas?

8. Toxic chemicals can drain off of farm fields in rainwater and flow into wildlife refuge lakes, pools, and streams, the program says. What are wildlife refuges a refuge from? Can wildlife find refuge from poisonous chemicals? How can wildlife be protected from farm toxins?

9. *Common Ground* points out that farmers have a hard time persuading wholesalers to buy more expensive organically grown crops, even though these crops are better tasting than those from high-tech farms and their cultivation causes less environmental damage. Do you think more farmers would grow organic crops if more consumers bought them? What does this suggest about the consumers' role in promoting environmental degradation? What does this suggest about the consumers' role in encouraging protection of farmlands? Can consumers blame farmers alone for using environmentally unsound agricultural practices? Would urban dwellers benefit from organically grown crops? How? Hint: Remember the environmental and health benefits.

FOLLOW-UP ACTIVITIES

1. Have a group of students investigate alternatives to the use of pesticides and report to the class. Have them include in their report information on how certain insects are being used to control other, crop-damaging insects, and how milky spore virus is being used to control Japanese beetles. They might also develop charts that compare the effectiveness of the alternative pest controls to the effectiveness of pesticides. Have them compare the human health hazards of each and make an argument for which is the most beneficial choice.

2. Invite a speaker from the state wildlife department to discuss department programs designed to help farmers manage their land for the benefit of wildlife. Have the students ask how a farmer qualifies for the program, how much farmland has been enlisted for wildlife management, how many farmers participate, what benefits the farmers receive, and how the wildlife lands differ in productivity from cultivated lands.

3. Ask students whose parents own farms if they can manage some land strictly for wildlife. Have them report on how management for wildlife differs from management for crops. Ask them to include a discussion of the physical differences they see in cropland compared to land managed for wildlife.

4. Overgrazing is a major problem throughout much of the West. Have a group of students prepare a report for the class on the problems caused by overgrazing of cattle and sheep. In the report they should address the following questions:

A. On what lands does the overgrazing occur?
B. What effect does overgrazing have on the land, water, and wildlife?
C. What efforts are being made to correct the problem?
D. Why weren't these lands overgrazed when millions of bison, elk, deer, pronghorn, and other hoofed species lived in the West?

5. Amish farmers practice low-intensity cultivation which does not rely on big machinery or chemical fertilizers. Have students develop a chart that compares Amish techniques to high-tech farming. Include information on crop yields per acre, costs, effects on wildlife, effects on the environment.

6. Have a group of students identify the federal and state laws that govern the use of pesticides and herbicides. Have them develop a chart that compares the laws and their administration by various agencies. Encourage the students to draw conclusions regarding state and federal environmental policies.

7. Contact a local farmer and arrange for a class visit. Ask each student to make the following observations while on the farm:

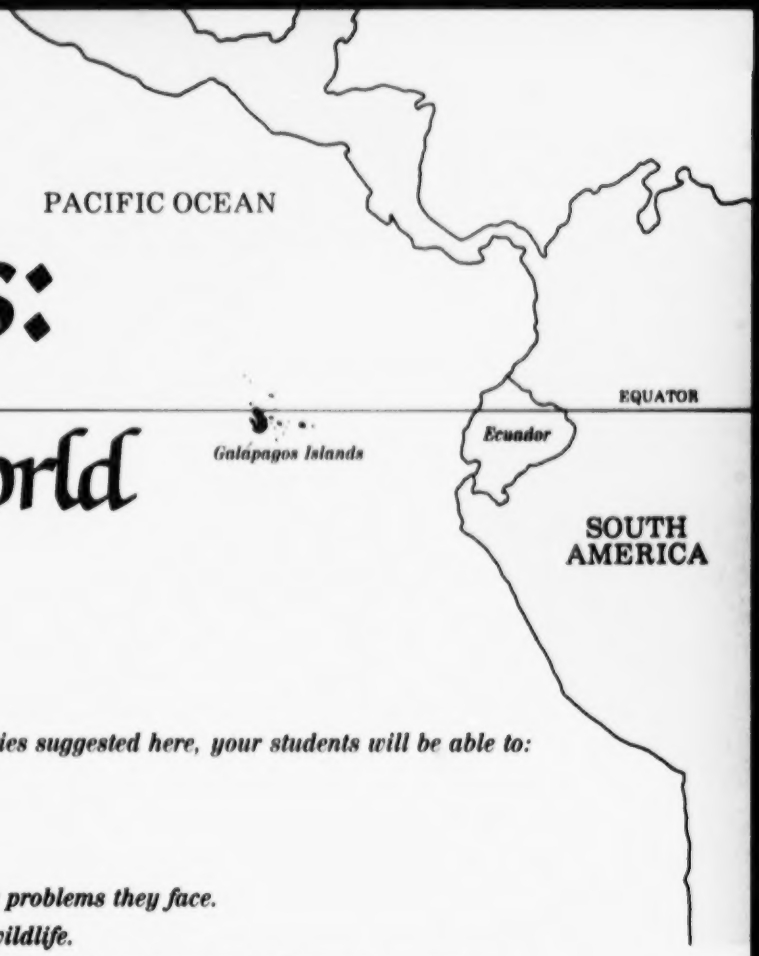
A. Examine the soil to observe its color and texture; observe the depth of any leaf litter that covers the earth.
B. Measure soil pH.
C. What kind of wildlife can be found in the soil? Above the soil?
D. What wildlife can be observed in the field? What wildlife sounds can be heard?

In a nearby wooded area have students make the following observations:

A. Examine the soil as was done in the farm field, including the amount of leaf litter that lies over the soil.
B. Compare the wildlife that can be seen in the woodland soil with that in the farm-field soil.
C. What wildlife can be observed in the woodland? What wildlife sounds can be heard?

Ask the students to draw conclusions regarding the effect of human changes on the environment.

8. Divide the class into three groups. Assign one group to report on soil, including information on how it is created from leaf litter; how nutrients from soil are used by plants; the differences among soils in dry deserts, bogs, pine forests, deciduous forests, and grasslands; how crop production affects soil; and how chemical fertilizers are used. Assign a second group to report on the water cycle, including information on cloud and rain formation, how water drains through soil, how it picks up chemicals and nutrients from soil and plants, how it reaches the water table, and how it gets into human drinking supplies. Information on these subjects can be found in college or high school ecology textbooks or can be obtained from the federal Department of Agriculture, your state equivalent, or a local office of the Soil Conservation Service. Assign the third group to report on how agriculture affects wildlife, including information on grazing on public lands in the West and plowing of farmlands. Assign specific students in this group to report on desert bighorn sheep, white-tailed deer, and prairie chickens as examples of animals affected by farming or grazing. Information on grazing can be obtained from the federal Bureau of Land Management. Information on the animal subjects can be obtained from your state wildlife agency or the U.S. Fish and Wildlife Service. Allow your students at least two weeks to get this material.



Galápagos:

My Fragile World

After viewing the program and participating in the activities suggested here, your students will be able to:

- *Locate the Galápagos Islands on a world map.*
- *Describe the wildlife of the Galápagos.*
- *Discuss the problems faced by Galápagos wildlife.*
- *Discuss the biology of island species in general and the problems they face.*
- *Evaluate the effect of human settlement on Galápagos wildlife.*
- *Describe how Charles Darwin's experience on the islands helped him develop the theory of evolution.*
- *Discuss how animals become adapted to their environment and to each other.*
- *Analyze the human role in the natural community.*
- *Evaluate the survival problems of wildlife in parks and refuges in light of the experience of the species on the Galápagos.*

PROGRAM SUMMARY

Galápagos, My Fragile World tells the story of Tui De Roy, a young woman who grew up on the Galápagos Islands some six hundred miles off Ecuador. It also tells the story of the islands themselves, exotic places that helped **Charles Darwin** formulate his theory of **evolution** and that today are attracting increasing numbers of visitors in search of an unusual wildlife experience. Through Tui's eyes the program teaches about a variety of wildlife species, including Galápagos tortoises, Darwin's finches, blue-footed and red-footed boobies, frigate birds, marine iguanas, and Galápagos penguins.

Galápagos, My Fragile World recounts how Tui came to the islands from Belgium with her parents when only two years old, and of how the islands have changed in the three and a half decades of her life. Again through her eyes, the program points out the hazards with which Galápagos wildlife must deal—the domestic dogs, cats, goats, horses, rats, and burros that have been released on the island and turned wild. These animals compete with native species for food plants; destroy **habitat**, in the case of goats and other herbivores, through overgrazing; and, in the case of rats, cats, and dogs, kill native species for food. Galápagos species are vulnerable to encroachment because they have evolved in isolation from competitors. Moreover, because the Galápagos has no native predators, many of the species are defenseless under attack. Some Galápagos birds, such as the flightless cormorant, have even lost the ability to fly.

Human visitation to the islands has mushroomed in recent years. Historically, people have brought destruction to the islands. Sailors took tortoises by the thousands in the times of sailing ships, keeping the hardy animals alive on ship and eating them when meat was needed. Beneath the onslaught of humans and domestic animals, several species became extinct. But today, human visitors have become part of the key to saving the islands. The government of Ecuador protects surrounding coastal waters and 98 percent of the islands themselves as a national park, and the increase in tourism makes preserving the park economically important. Because tourism is well regulated and brings money into the national economy, it is said that Galápagos wildlife is better protected from man than from animal predators. Programs also are being conducted to limit the damage that nonnative animals do to native species, including efforts to limit populations of feral domestic animals and captive-breeding programs for jeopardized species. As the narrator concludes, conservation in the Galápagos is, so far, a success story. What happens there in the future will be a test of man's relationship with nature.

BACKGROUND MATERIAL

The most commonly seen of the three booby species native to the Galápagos is the blue-footed booby. It nests in small colonies often located near the coasts and feeds close to shore. Mated pairs lay one to three eggs on bare ground, and both parents help with incubation. Because the eggs are laid three to five days apart, they hatch at similar intervals. During periods of food scarcity, the first chick to hatch, as the oldest and strongest in the clutch, may be the only one to survive. When food is plentiful, all three hatchlings may survive. The male provides most of the food for newly hatched young, but as the young birds mature they need more food and the mother begins to help with feeding. Adults dive into the sea to capture prey. Sometimes thousands of blue-footed boobies will hunt together, diving in unison.

The red-footed booby is the smallest Galápagos booby and the most abundant, though it is the least often seen. It flies far out to sea to find the squid and flying fish on which it feeds. It nests in trees. A single colony may have well over 100,000 nests.

Largest of the boobies is the masked booby, with a wing span in excess of four feet. It nests on the ground in colonies near cliffs and other promontories. Pairs lay two eggs, only one of which survives because the stronger of the two hatchlings always kills the weaker.

Thirteen species of drab, sparrow-sized finches occur on the Galápagos, each species adapted to different feeding habits and bearing a characteristic beak. Because of their basic similarity to one another, Charles Darwin speculated that they all evolved from a single ancestor that diversified into several species when various populations became isolated from one another and increasingly adapted to different feeding patterns. The birds were critical to Darwin's development of evolutionary theory and are so closely linked to the theory that as a group they are called Darwin's finches.

The special conditions of the Galápagos Islands are reflected in the evolutionary peculiarities of other species found there. The flightless cormorant apparently lost the ability to fly as it became increasingly adapted for swimming. It was able to survive without flight because its habitat lacked predators and the sea provided an abundant and nearly food source. Courtship takes place in the water. Mated pairs build nests of seaweed on rocky shores. They lay two or three eggs. Both parents help rear the young. Probably no more than 1,500 flightless cormorants exist.

Two species of frigate birds, the great and the magnificent frigate, live on the Galápagos. They are large black seabirds. The males have large, bright red throat pouches that they inflate when trying to attract mates by calling. When hunting, frigates skim over the surface of the sea, snapping up prey with their beaks as they fly. The birds try to avoid prolonged immersion as their feathers become easily water logged. They also steal food from other birds.

Some species are imperfectly adapted to the Galápagos and can survive there only in certain limited regions that meet their specific needs. One of these is the Galápagos fur seal, which is really a type of sea lion. It is found in the cooler waters of the Galápagos because it is intolerant of the heat prevalent in the island area. In the Nineteenth Century hunters nearly wiped them out, killing thousands for their furs. They live in colonies along shore, going out at night on hunting forays for squid and fish. They apparently avoid hunting during the full moon, when the bright light makes them more vulnerable to sharks. They number some 50,000 animals. They are similar to the Galápagos sea lion, with which they share the islands.

The Galápagos penguin, the only penguin that occurs north of the equator and nests in the tropics, like the Galápagos fur seal is also intolerant of heat. Descendants of birds adapted to cold, the Galápagos penguins live where sea waters are cool. On land they hold their wings out and keep their feet shaded so that heat can be lost from these limbs. On warm days they hide in the shade or go into the water. The penguins mate for life and lay their eggs in holes, crevices, and other shaded sites to keep them from the sun.

The giant Galápagos tortoises contrast distinctly with the penguin and fur seal because they are well adapted to life on the dry, hot islands. Fourteen subspecies of giant tortoises probably lived in the Galápagos until Nineteenth Century sailors hunted four of them into extinction. The tortoises are vegetarians and can live for up to a year without food or water. Their longevity is uncertain, but they almost certainly can live more than a century. Before contact with humans, they probably numbered a quarter of a million, but today may number no more than 15,000. They still face threats from domestic predators introduced to the islands by people.

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"Galápagos"stems from the Spanish word for tortoise, galapago. One unique Galápagos species is the marine iguana, the only seafaring lizard in the world. It can survive immersion for up to an hour. During most of the year, marine iguanas live in large groups along shore. Large males will leave the shore at midday, after the sun has warmed their cold-blooded bodies, and dive offshore to feed on algae. When they return to shore later in the day, the sea has cooled their bodies considerably and they lay on the rocks to absorb warmth from the sun. Females and smaller males feed on exposed reefs and on rocks exposed during low tide, since they are not strong enough to swim through ocean breakers. Males become territorial during the breeding season, and females become territorial while nesting. Females lay two to four eggs in sandy nests. They guard the nests from other females.

PRE-VIEWING ACTIVITIES

Have students locate the Galápagos on the map of the world. Ask students to speculate about the kind of conditions you should expect to find at that longitude and latitude. Ask students to discuss what they know about the Galápagos and the work of Charles Darwin.

DISCUSSION QUESTIONS

These are open-ended questions that lack definitive answers. They are meant to encourage discussion about the Galápagos Islands and creatures faced with living in confined habitats.

1. *In Galápagos, My Fragile World*, the narrator says that creatures on the islands never evolved protective behaviors. Why did this happen? What affect has it had on Galápagos species now that people, with their pets and pests, have invaded the islands? What does this example suggest about the role of predators in the evolution of prey species?

2. The program narrator states that giant tortoises were once widespread. They could be found in Texas only 25,000 years ago, a short time in geological and evolutionary history. Today they are found only on the Galápagos and on a single island in the Indian Ocean. Why would these tortoises survive only on these islands? What does this suggest about competition between species? What does this example suggest about the kinds of places where living fossils are most likely to be found. Hint: Continents have a greater diversity of species than do islands, including greater numbers of predators.

3. Jacqueline De Roy, Tui's mother, says that many people have tried to adopt their lifestyle on the islands, but that few have ever succeeded. What would have happened to the islands had great numbers of people been able to adopt the De Roy lifestyle? What would have happened to the wildlife? How does the harshness of the Galápagos help to protect them?

4. What feeding behavior did Darwin's finches demonstrate in the program? How is this behavior evidence of adaptation to the Galápagos? What did this suggest to Charles Darwin about how species evolve?

5. The narrator states that in the 1950s the Galápagos' contact with the outside world was an old supply ship that visited twice yearly. Today, a town has been built on Academy Bay, and the bay is busy with visiting yachts. The old economy was based on fishing and agriculture, but now tourism is the major employer. What affects do you think these changes have had on the islands? Is tourism a good or bad development for wildlife and habitat? Compare the affects of tourism with those of fishing and agriculture. Is wildlife better off now than it was? Explain your answer. Hint: Tourism relies on a protected and intact wildlife ecosystem. Fishing could compete with sea lions for food, and agriculture might destroy wildlife habitat.

6. What does the program suggest is the significance of the blue- footed booby's feet and of the frigate's throat pouch? Why would signals such as these evolve? Hint: Many animals have physical features that help identify the species to which the animals belong. These features help deter breeding between members of closely related species. The evolutionary pressure to develop the features would be strong because individuals without the features would either fail to breed or might breed with members of the wrong species, thus leaving no offspring to carry on their genes.

7. What does the narrator of the program say about the effect of feral domestic animals, such as cats, dogs, rats, and goats, on the Galapagos? Why are the native species unable to cope with the domestic animals?

8. In *Galápagos, My Fragile World*, Tui states that she has seen boobies abandon their young to starvation when food is scarce. Why would the boobies do this? What would happen if the boobies did not do this? What is a limiting factor ? Is lack of food a limiting factor for boobies? When—all the time, part of the time? What factors might be limiting to finches? To marine iguanas? To sea lions? To people? How do limiting factors influence the distribution of animals? Hint: Islands that lack water, for example, have not been settled by humans.

9. The theory of evolution teaches that all animal behaviors are adaptive, helping their inheritors to survive. Tui says in the program that newly hatched tortoises remain underground in their nests for about four to six weeks. How would this be adaptive? Hint: Their skins are still thin, so they might suffer injuries above ground; they also would be more likely to fall prey to predators when outside the nest. In what other ways are tortoises adapted to life on the islands?

10. *In Galápagos, My Fragile World*, Tui De Roy reflects that living on the islands gives her a basic understanding about the relationship between all living creatures. "We're not man as apart," she says, "we're not man as a different entity from the rest of the wild world, but we're part of the natural world." What natural roles

does man play in the environment? Is he a predator? Is he prey? What indirect roles does man play when he brings domestic animals into a new environment? All creatures need food, water, and shelter, but how does man differ from other species in his pursuit of these needs? In what ways is man, as a part of the natural community, affected by the environment? How is he affected by the changes he himself brings to the environment? Use the Galápagos and your own state as environmental examples.

11. Tui De Roy, while watching baby fur seals and and boobies, observes that curiosity seems to be an ingrained trait in many animals. Is curiosity usually greater in older or younger animals? What are the risks of being curious? What are the disadvantages? Why would it be advantageous for one age-group to be more curious than another about its environment? What role has curiosity played in the development of the human species? How would the world differ today if humans were not curious? How may an adaptive trait, such as curiosity, aggression, or intelligence, become maladaptive?

12. As a group, penguins are adapted to cold environments, but the Galapagos penguin is found near the Equator. How has the Galapagos penguin managed to find a niche of its own in the warmer environment of the Galápagos? What does this suggest about the ways in which an animal's adaptations restrict it to particular environments? What would happen to a species whose environment has been radically altered, for example by human environmental changes? Hint: Remember Tui De Roy's comments on the shoreline of Fernandina.

13. The narrator points out that conservation in the Galápagos is a success story, but says that funds for protection of the islands are limited and that protection could be affected by political or commercial interests. What accounts for the greater part of the economy in the Galápagos? How would the discovery of oil, gold, or some other valuable commodity affect protection of the islands? Do you think natural environments should be saved in cases in which economic development would ruin an environment? In all cases, or only in some cases? Why? The Galápagos Islands are small, out-of-the-way fragments of land populated by a handful of economically unimportant species, but what importance have they had to humanity? Hint: Remember the development of Darwin's theory of evolution. Is what can be learned from a natural area, such as the insights Darwin gained from his visit to the Galápagos, as important a consideration as an area's economic value? Why?

FOLLOW-UP ACTIVITIES

1. Tui De Roy in *Galápagos, My Fragile World*, tells about a type of Darwin's finch that has learned to eat ticks off of tortoises. Such a relationship is called mutualism, because it benefits both of the species involved. Ask a group of students to write a report on other examples of beneficial relationships between two species, such as that between rhinoceroses and the birds that ride on their backs and certain species of fish that live within the poisonous tentacles of sea anemones. Have another group of students research relationships that benefit only one species, such as the parasitic nesting of cowbirds and cuckoos and the relationship between remoras and sharks. Compare the two kinds of relationships in a class discussion.

2. Assign a group of students to develop a report on the fate of island species on Madagascar, Hawaii, and Guam and to develop a chart that compares the fate of these species with that of similar Galápagos species. Find out what accounts for the similarities and differences. Determine how many of the similarities are a product of the island environment. Hypothesize about what this suggests about the survival of island species into the distant future.

3. Ask a group of students to report on the teachings of island biogeography. Have them find out about the basic biological similarities of all animals existing on islands, including the conditions that make their survival tenuous in the face of disruptions. The biological problems encountered by island species are providing conservationists with a better understanding of the problems encountered by animals in national parks and on wildlife refuges. Suggest that they find out why this is so. Have them prepare reports or charts that compare the problems of island species with those of animals such as the grizzlies of Yellowstone National Park.

4. Darwin's theory of evolution concerns biological adaptations to the environment. Humans and perhaps some animals can also adapt culturally to environmental challenges. Ask students to write a report that compares cultural with biological adaptations. Ask them to discuss what the differences in the speeds of cultural and biological adaptation suggest about the fate of species confronted by human development.

5. Arrange a visit to a city park or a wildlife preserve surrounded by agricultural land. The city park and the preserve both function in some ways as islands. Have a group of students find out what limits the number of animals that can survive within these "islands." They should hypothesize during class discussion about what will happen to species whose numbers are too great for the park or preserve to support. Have them compare this fate with what would have happened to these animals before the land around them was developed. Also have the students compare the plight of these local species with what is known about species found on real islands. Suggest that they consider what this implies for the protection and management of animals isolated within parks and preserves.

6. Assign students to develop a report on "selective pressure." The report should compare the selective pressures faced by island species with those faced by continental species. Because the selective pressures of one island tend to be similar to those of other islands, island species share similar adaptive traits. Have students ex-

plain what these traits are, using the dodo, flightless cormorant, and Florida key deer as examples. Based on their studies, students should predict what might happen to species such as the grizzly bear, wolf, mountain lion, elk, and bison.

7. Have students look up the terms "divergent evolution" and "convergent evolution." Although similarities of appearance in animals do not always indicate an evolutionary relationship, in many cases they do. Arrange a visit a zoo. Have the students examine a variety of animals and enter the animals' names on lists with the following headings: even-toed hoofed mammals, odd-toed hoofed mammals, meat-eating mammals with retractable claws, meating-eating mammals with nonretractable claws, aquatic mammals with flippers, mammals with true hands and prehensile tails, mammals with true hands and nonprehensile tails. Have the students compare their lists to the classification of mammals that appears on a mammalian evolutionary tree. Have a class discussion about how closely the animals grouped together on the various student lists match the classification of mammals. Have the students determine what characteristics they would have to use to refine their lists in a way that would match the biological classification. Accelerated students should be assigned to prepare reports on how physical traits can be used to discover evolutionary relationships among various groups of animals.

8. Divide your class into two groups. Assign one group to report on the geology and history of the Galápagos Islands, including information on when and how the islands developed, why some islands are hotter and drier than others, when and how people discovered the islands, and how people have used the islands. Assign the other group to report on the wildlife of the islands, supplying a list of birds, reptiles, and mammals with information on how the various animals reached the islands.

9. Assign the class a report on evolution that includes information on genetics (what are genes, chromosomes, meiosis, mitosis, mutation, and adaptation?), evolutionary theory (who are Jean Lamarck, Eramus Darwin, Charles Darwin, Alfred Wallace, Thomas Huxley, and Gregor Mendel and what did each contribute to evolutionary theory), and the evolution of the horse (an animal that provides a relatively complete evolutionary record).

General Glossary

Adaptation—a physical or behavioral characteristic of a living organism that permits it to live within a certain environment. For example, the marine iguanas of the Galapagos possess a variety of adaptations that permit them to lead sea-faring lives, including a tail that is flattened into a sort of paddle, the ability to lower heart rate during dives to reduce use of oxygen, and the ability to expel from their nostrils the salts that build up in their bodies. They also possess behavioral adaptations, such as orienting their bodies in sunlight to maximize exposure, thus hastening the warming process. Animals that lead similar lifestyles, i.e. that fill similar environmental niches, tend to have similar adaptations. Thus, cold adapted species tend to have dense fur or feathers and/or fat beneath the skin for insulation; predators tend to have sharp teeth or beaks and, if terrestrial, sharp claws. A species' adaptations can provide clues about its behavior even if the species has never been observed alive. For example, much can be inferred about the behaviors of prehistoric animals known today only as fossils by studying their skeletal adaptations.

Bureau of Land Management—this agency within the Department of the Interior manages some 270 million acres, more than any other federal agency. Most of these lands, which comprise sixty percent of all federal lands, are in the West. The bureau is responsible for oil and mineral development on its properties and is closely tied to the livestock industry because much of its land is leased to ranchers for grazing. Activities such as these often put it at odds with the needs of wildlife on the lands. For example, livestock compete with wildlife for scant water sources and, when present in dense numbers, can eat the bulk of all grasses and other plant foods. Called overgrazing, such destruction of habitat can have long-term and devastating effects. With proper management, however, livestock and wildlife can coexist.

Bureau of Reclamation—established by Congress in 1902, this agency within the Department of the Interior administers water-resource development in the West. Its mandate requires it to provide for fish and wildlife protection, recreation, farm irrigation, municipal and industrial water needs, flood control, and other activities.

California I partment of Fish and Game—this state agency is responsible for the conservation of California wildlife. The bulk of state agency budgets are financed by the sale of hunting and fishing licenses and by a federal tax on hunting and fishing gear. Consequently, state agencies focus their work primarily on game species, animals that are hunted or fished for sport. The states set the hunting and fishing seasons and limits for most wildlife species. The major exception is migratory bird management, which is controlled primarily by the U.S. Fish and Wildlife Service. During the past decade nonconsumptive wildlife enthusiasts—those who enjoy nature and wildlife but do not hunt or fish—have pushed the state agencies to broaden their programs to include nongame species and endangered wildlife. Various funding sources, such as state income tax programs that allow taxpayers to donate a portion of their refunds to a state nongame program, have helped spur the state agencies to divert some of their expertise into nongame work.

Darwin, Charles—Darwin was twenty-two years old when on December 27, 1831, he set sail on the *H.M.S. Beagle* on a five-year voyage round the world. He had only recently completed his education at Cambridge, which he had entered to study for the clergy. At Cambridge, however, his interest in natural history was inspired. He sailed on the *Beagle* as the ship's naturalist. His observations covered not only wildlife but also geology and paleontology. Upon his return to England he married and became increasingly sedentary and subject to ills, real or imagined. But he also increasingly refined the theory of evolution toward which his observations on the *Beagle* voyage had compelled him. In 1859 he published *The Origin of Species*. The theory met the immediate hostility of the conventionally religious and even of the conventionally scientific. Darwin preferred to avoid the fray, letting friends such as Thomas Huxley fight his public battles. In the ensuing decades the truth of the theory became more and more apparent. Today it is one of the broad foundations of biology and a crucial key to understanding life. Darwin also wrote classic studies on coral atolls, orchids, and on the expression of emotions in humans and animals. He died in 1882.

Endangered Species Act—the federal law that gives special protection to animals that have been designated as endangered or threatened. Endangered species are those vulnerable to extinction throughout all or a portion of their range. Threatened species are those that, if no measures are taken to protect them, could become vulnerable to extinction throughout all or a portion of their range. Species are nominated for listing by a government agency or a private group or citizen. If the nomination is accepted, the U.S. Fish and Wildlife Service, or the National Marine Fisheries Service in the case of marine species, must review the species' status and within a year decide whether listing is necessary. Four hundred and fifty-five species are currently listed, but thirty-eight hundred are candidates. At the current rate of listing, all of these species will not be reviewed for another seventy-six years. Because nearly a thousand are severely jeopardized, many will vanish before ever being reviewed.

Once a species is listed, a recovery team is supposed to be appointed to develop a recovery plan that serves as a guide for protecting the species and augmenting its numbers. However, only fifty-five percent of the listed species have recovery plans.

The act prohibits citizens from harming listed species and forbids the use of federal funds in any project, such as a harmful dam or landfill, that would jeopardize such species. Unfortunately, in some cases in which the presence of an endangered species seemed about to stop a federal project, Congress made changes in the law to allow the project to go ahead. Also, conservationists in many cases are reluctant to evoke the law out of fear that Congress will weaken the act if it is used too vigorously to stop harmful projects. Nevertheless, the Endangered Species Act is still one of the strongest wildlife-protection laws in the world.

Evolution—the process through which a variety of species springs from a single common ancestor. Basically, evolution teaches that the future belongs to the individuals that produce the most surviving offspring, since it is their physical and behavioral traits that will survive. These traits are controlled genetically and can be changed by mutations in the genes. Though usually harmful, mutations are sometimes adaptive and occur with relative frequency. Consequently, if two pop-

ulations of a single species become geographically isolated from one another for many generations, the populations may slowly diverge genetically until they become two different species. Traditionally, it has been thought that species evolved entirely through geographic isolation and the slow accumulation of adaptive mutations, but current research is increasingly suggesting that evolution may also take place in sudden mutational leaps, even without geographic isolation.

Biological evolution is a relatively slow way to adapt to environmental changes. For example, the Galápagos penguins, which live in an environment that places them on the edge of their ability to tolerate heat, could be doomed by a global warming trend unless sudden mutations divested them of their adaptations to cold. Of course, this is highly unlikely. Humans have been so biologically successful because they can adapt to change not only biologically but also culturally, for example by removing or adding clothing as needs demand. Cultural adaptability frees an organism to a certain extent from the vagaries of its environment.

Florida Game and Fresh Water Fish Commission—the agency responsible for management of the state's wildlife. For more detail on state wildlife agencies, see the entry on the California Department of Fish and Game.

Habitat—the place in which an animal or plant occurs. It can be quite large. The mountain lion's habitat once included most of North America. Habitat can also refer to a portion of a species' range, for example the mountain lion's habitat in Florida, or in the Rocky Mountains. Habitat can also be another animal. Habitat for a deer tapeworm would include the intestine of the deer.

Imprinting—animal behaviorists believe that in many species newly born individuals learn their species identities from the first animal they see. For example, in one early study ethologist Konrad Lorenz imprinted domestic geese on himself by letting them see only him for the first hours after they hatched. Forever after that, the goslings would follow him as if he were their parent. Animals reared by humans often become imprinted on people. They become, in a sense, programmed to think they are human and will refuse to mate with members of their own species. It is particularly important that imprinting on humans be avoided with captive California condors, whose need for increased numbers is paramount to their continued existence. Consequently, as the program explains, measures are being taken to avoid human imprinting of the condors. Use of the artificial condor head when feeding and grooming hatchlings should help the birds to develop natural bonds with their own species. Traditional wisdom teaches that imprinting is irreversible. However, some research with laboratory rats in the early 1970s suggested that if a social animal were isolated for a long time, its imprinting program would break down to the point that it could be reimprinted on a new species.

Inbreeding—a serious problem faced by the condor, Florida panther, and many other endangered species is rooted in the small numbers of surviving animals. For some species only a single population survives. Until their capture, this was true of the California condor. This put them in special jeopardy, since a single catastrophic event, such as a deadly contagious disease, could wipe out all the birds in one fell swoop.

Small populations face another vital problem, inbreeding. Inbreeding occurs when closely related individuals mate and have offspring. In nature, this is usually avoided, for example by natural dispersal patterns. But in a small population natural deterrents to inbreeding may fail because few animals are available for mates. Inbreeding is dangerous because it encourages the appearance of harmful genetic traits. Generations of inbreeding also seems to affect sperm production in males, reducing their potency. The best solution is to avoid letting wild populations sink to extremely low levels before an effort is made to protect and preserve them.

Limiting Factor—a feature of a species' environment or habitat that puts limits on the species' range or numbers. Food may be a limiting factor right now for panthers in Florida. Warm climatic conditions may be a limiting factor for penguins in the Galapagos.

Parasite—parasites are organisms that affix themselves physically to other species, called the hosts, and feed off of them. Ecto-parasites live on the outsides of their hosts; examples include ticks. Endo-parasites live inside their hosts; examples include hook and tape worms. The fate of the parasite often depends on the survival of its host. For example, an intestinal worm dies too if it kills its host. Consequently, the best adapted parasites do little damage to their hosts, the result of increasing adaptation through generations of relationship. The amount of damage a parasite does to its host may be a clue to how long the host and parasite species have been in contact.

Poachers—people who illegally take or kill wildlife for personal gain. In some states, poaching of fish for sale to restaurants is a multi-million-dollar business. Sale of poached deer meat to restaurants is also prevalent in some states, where it is estimated that the illegal kill of deer equals the legal kill. In New Mexico and Oklahoma many birds of prey, including bald and golden eagles, and thousands of songbirds such as the scissor-tailed flycatcher have been poached to supply feathers for traditional Indian craft items sold as souvenirs.

Pyramid of Life—a graphic portrayal of the movement of energy through the food chain. At the broad bottom are the plants that trap the sun's energy. At the next, smaller, level are the creatures that eat plants. Above them are the predators, which make up the peak. A variety of sublevels exist within each level, and some creatures move between levels. Grizzly bears, for example, sometimes are predators and sometimes are grazers. Levels grow smaller as they go upward because food species must always outnumber the creatures that feed upon them.

Radio Telemetry—the use of radio transmitters to study animals in the wild is a procedure that is barely three decades old. However, the technique has revolutionized the study of wild animals and opened hitherto locked doors on certain aspects of animal behavior. The use of radio telemetry on condors, black-footed ferrets, and badgers is shown clearly in the programs. Radio transmitters are used on a wide variety of species, from bears and birds to lizards and snakes. The equipment is becoming increasingly sophisticated. In the early years, the transmitters revealed only the animal's location. Now transmitters are being used that also relay body temperature, rate of breathing and heart beat, and other physiological information. Some even change the signal to indicate that the tagged animal has died.

Specialization—specialized animals are those with very limited environmental and behavioral needs. For example, the Australian koala eats primarily eucalyptus leaves, and the giant panda of China eats primarily bamboo. Should anything happen to those plant-food sources, the koala and the panda could be threatened with imminent extinction. Choice of habitat can also specialize an animal. Some bats need certain distinct types of caves for shelter. Because human interference has altered some bat caves in the United States, some bat species have declined within a decade from millions of individuals to only a few hundred or few thousand.

The opposite of specialized is generalized. The coyote, a wild canine closely related to the wolf and the domestic dog, is an example of a generalized animal. It eats a wide range of foods, from persimmons to rabbits to carrion to grasshoppers. It also can survive in a variety of habitats, including mountains, deserts, woodlands, and prairies. Such a species is less vulnerable to extinction because if it loses one food source or habitat type, it can switch to another.

U.S. Fish and Wildlife Service—part of the Department of the Interior, the Fish and Wildlife Service is the federal government's lead agency for the conservation and protection of fish and wildlife and their habitat. Except for a handful of marine species, it is responsible for the protection of all the animals and plants listed under the Endangered Species Act. It also is responsible for the management of some ninety million acres in the National Wildlife Refuge System and for the protection of some 830 migratory bird species including waterfowl, as well as interstate and international commerce in wildlife and wildlife products.

U.S. Forest Service—established in 1905 to manage the cutting of trees for timber in federal forests, the service administers 191 million acres in the National Forest System. The system houses some three thousand wildlife species, including one hundred and twenty-nine listed as endangered or threatened. It is a multiple-use agency, which means that its lands are supposed to meet a variety of sometimes conflicting uses, including logging; recreational activities such as camping, hiking, and fishing; mineral and oil development; wildlife protection; and grazing of livestock. The Forest Service is part of the Department of Agriculture.

Wetlands—any of a variety of submerged lands, including swamps, marshes, and estuaries. The federal government protects wetlands through programs administered by the U.S. Army Corps of Engineers and the Environmental Protection Agency, which differ in their definitions of what constitutes a wetland. These differences in definition have led to disputes about which wetlands should be protected.

Wyoming Game and Fish Department—the agency responsible for management of the state's wildlife. For more detail on state wildlife agencies, see the entry on the California Department of Fish and Game.

Information Directory

Bureau of Land Management
Division of Wildlife
Department of the Interior
C Street and 18th Street NW
Washington, DC 20240

Bureau of Reclamation
Department of the Interior
C Street and 18th Street NW
Washington, DC 20240

California Department of Fish and Game
Wildlife Management Division
1416 Ninth Street
Sacramento, CA 95814

California Research Station
(formerly the Condor Research Station)
National Audubon Society
2291A Portola Road
Ventura, CA 93003

Florida Game and Fresh Water Fish Commission
620 S. Meridian Street
Tallahassee, FL 32301

National Association of Biology Teachers
11250 Roger Bacon Drive, #19
Reston, VA 22090

National Audubon Society
950 Third Avenue
New York, NY 10022

National Park Service
Interior Building
P.O. Box 37127
Washington, DC 20013-7127

U.S. Fish and Wildlife Service
Endangered Species Research
Patuxent Wildlife Research Center
Laurel, MD 20708

U.S. Fish and Wildlife Service
Division of Endangered Species and
Habitat Conservation
Department of the Interior
C Street and 18th Street
NW Washington, DC 20240

U.S. Fish and Wildlife Service
Office of Migratory Bird Management
Department of the Interior
C Street and 18th Street NW
Washington, DC 20240

U.S. Forest Service
Director of Wildlife and Fisheries
P.O. Box 2417
Washington, DC 20013

References

Asterisk denotes references that students in grades 7 through 9 should be able to read and understand readily; advanced readers may find some unmarked entries useful.

Periodicals that will provide more information on the conservation issues introduced in the television programs include *Audubon*, published bimonthly by the National Audubon Society, 950 Third Avenue, New York City, NY 10022; *Wilderness*, published quarterly by the Wilderness Society, 1400 I (Eye) Street NW, 10th Floor, Washington, DC 20005; *Sierra*, published bimonthly by the Sierra Club, 730 Polk Street, San Francisco, CA 94109; and *Defenders*, published bimonthly by Defenders of Wildlife, 1244 Nineteenth Street NW, Washington, DC 20036.

Allen, Thomas B., editor. 1987. *Wild Animals of North America.** National Geographic Society. Washington, DC. Excellent survey of North American species, well illustrated with color photographs. The text is easily accessible to younger readers.

Ammann, Katherine and Karl Ammann. 1985. *Cheetah*. Arco Publishing Inc. New York. Illustrated with dazzling color photographs. Text is suitable for young readers.

Bean, Michael J. 1983. *The Evolution of National Wildlife Law*. Praeger Publishers, New York. Provides a detailed examination of the development of U.S. federal wildlife laws, including the Endangered Species Act.

Bent, Arthur Cleveland. 1961. *Life Histories of North American Birds of Prey, Part One.** Dover Publications, Inc., New York. The condor chapter in this volume from Bent's ambitious series on North American birds provides excellent historical information. Originally published in 1937.

Campbell, Neil A. 1978. *Biology*. Benjamin-Cummings Publishing Co. Menlo Park, California. A new, comprehensive, current, and innovative college general biology textbook with evolution as a central theme throughout.

Carson, Rachel. 1962. *Silent Spring.** Houghton Mifflin Co. New York. Dated, but still a classic. The book that led to the ban on use of DDT and ultimately to a tightening of controls on all toxic chemicals.

Darwin, Charles. 1972. *Voyage of the Beagle.** Bantam Books. New York. Highly entertaining account of the trip that took Darwin to the Galápagos. A window on a lost age.

Darwin, Charles. 1968. *The Origin of Species*. Penguin. New York. The book that first expounded the theory of evolution. A classic, and a model of fine scientific research. Perhaps difficult for younger readers and not particularly stimulating to nonscientists.

Day, David. 1981. *The Doomsday Book of Animals.** The Viking Press, New York. Well-illustrated, somber book about recently extinct animals. Good for young readers and old.

Dobzhansky, Theodosius. 1962. *Mankind Evolving: The Evolution of the Human Species.** Yale University Press. New Haven. Though somewhat dated, this is an excellent background not only on human evolution, but also on genetics in general. The writing clarifies difficult, complex subjects even for readers with rudimentary scientific knowledge.

Eaton, Randall L. 1981. *The Cheetah: Nature's Fastest Racer*. Dodd Mead. New York. Well illstrated account of cheetah natural history designed for younger readers.

Eckert, Allan W. 1973. *Silent Sky: The Incredible Extinction of the Passenger Pigeon.** Landfall Press. Fictionalized but accurate account of the extinction of the passenger pigeon, once the most numerous bird in North America. Good for younger readers.

Erlich, Paul and Anne Erlich. 1981. *Extinction: The Causes and Consequences of the Disappearance of Species.** Random House, New York. Fine, disturbing account of the factors that lead species to extinction.

Frame, George and Lory Frame. 1981. *Swift and Enduring*. Elsevier-Dutton Publishing Co. New York. The Frame's account of their four years at Tanzania's Serengeti Research Insititute, during which they studied both cheetahs and wild dogs.

Graham, Frank Jr. 1977. *Since Silent Spring.** Fawcett. New York. A sequel to Carson's *Silent Spring*. Fine book written in a readily accessible style.

Graham, Frank Jr. 1984. *The Dragon Hunters.** E.P. Dutton, Inc. New York. Well-written account of the work being done to find alternatives to use of chemicals in agriculture.

Grzimek, Bernhard. 1975. *Animal Life Encyclopedia.** Van Nostrand Reinhold Co. New York. Thirteen giant volumes that cover virtually the whole animal kingdom, even down to the species level. Can give the reader an excellent background on a myriad of species, though other sources may be needed for in-depth material.

Jackson, M.H. 1985. *Galápagos, A Natural History Guidebook*. University of Calgary Press. Calgary, Alberta. Excellent, readable survey of Galapagos Islands wildlife. The source for the information in the "Background" section of the Galapagos unit.

Johnsgard, Paul. 1978. *Ducks, Geese, and Swans of the World*. University of Nebraska Press. Lincoln. Good survey of waterfowl natural history.

Lack, David. 1961. *Darwin's Finches: An Essay on the General Biological Theory of Evolution*. Harper Torchbook. New York City. An update of Darwin's work, using advances in evolution theory.

McMillan, Ian. 1968. *Man and the California Condor.** Dutton, New York. Excellent survey up to the late 1960s of condor history and protection, written by one of the first credible condor researchers.

McNulty, Faith. 1971. *Must They Die: The Strange Case of the Prairie Dog and the Black-footed Ferret*. Doubleday. Garden City, New York. Only 86 pages long, this book provides a fine account of the conflict between ferret survival and the poisoning of the prairie dog.

Moore, Tui De Roy. 1980. *Galhpagos: Islands Lost in Time.** Viking Press. New York City. Striking, full-page color photographs by the woman spotlighted in the program, *Galápagos, My Fragile World*.

Nilsson, Greta. 1983. *The Endangered Species Handbook.** Animal Welfare Institute. Washington, D.C. A fine source for endangered species advocates. Covers causes and consequences of vanishing species and endangered species legislation and programs. Includes an elaborate directory of resource agencies and student activities.

Nowak, Ron and John Paradiso, editors. 1983. *Walker's Mammals of the World*, Fourth Edition. The John Hopkins University Press. Baltimore. A definitive survey of the world's mammals. Illustrated with black and white photographs. Includes concise, encyclopedic text on most, if not all, mammalian species.

Ogden, John C. 1985. "The California Condor" in *Audubon Wildlife Report 1985*, Roger L. DiSilvestro, ed. National Audubon Society, New York. Technical article by a leading condor researcher. Covers the biology, history, and management of the California condor.

Paddock, Joe; Nancy Paddock, and Carol Bly. 1986. *Soil and Survival Land Stewardship and the Future of American Agriculture.** Sierra Club Books. San Francisco. Provides a good background on the whole agricultural problem, including historical and religious references and information on American Indians and agriculture.

Phillips, David and Hugh Nash, eds. 1981. *The Condor Question, Captive or Forever Free?** Friends of the Earth, San Francisco. Excellent survey of the controversial viewpoints of those who opposed captive breeding of condors.

Pye, Veronica I.; Ruth Patrick, and John Quarles. 1983. *Groundwater Contamination in the United States*. University of Pennsylvania Press. Philadelphia. Technical. Provides a strategy for protecting groundwater.

Savage, R.J.G. and M.R. Long. 1986. *Mammal Evolution, An Illustrated Guide.** Facts on File Publications. New York. Excellent for all readers, with lavish illustrations.

References

Schroeder, Max. 1987. "The black-footed ferret" in *Audubon Wildlife Report 1987*, Roger L. DiSilvestro, ed.. Academic Press. San Diego. Technical account of the natural history and management of the ferret.

Schorger, Arlie W. 1973. *Passenger Pigeon: Its Natural History and Extinction*. University of Oklahoma Press, Norman. Excellent, exhaustive account of how a bird that numbered in the billions in 1800 vanished from the wild hardly a century later and sank into extinction in the Cincinnati Zoo in 1914.

Seton, Ernest Thompson. 1953. *Lives of Game Animals*.* Charles T. Branford Co. Boston. Highly readable though much dated survey of virtually all North American mammal species.

Simpson, George Gaylord. 1971. *The Meaning of Evolution*. Bantam Books. New York. A good companion to Dobzahnsky's book (see above). Provides the nonscientist with the basics of general evolution. Somewhat dated.

Smith, Dick and Robert Easton. 1964. *California Condor: Vanishing American*.* McNally and Loftin, Charlotte, NC. Good overview of the condor and its habitat, mythology, and history. Good for younger readers.

Smith, Richard J. and Olive Kingston Smith, eds. 1978. *Condor Journal*. Capra Press, Santa Barbara, CA. Includes the complete text of Richard Smith's *California Condor: Vanishing American* plus entries from the journal he kept during thirteen years of wandering in condor country. Good for younger readers.

Todd, David Keith and Daniel E. Orren. 1976. *Polluted Groundwater: A Review of Significant Literature*. Water Information Center, Inc. Port Washington, New York. Provides some information on groundwater pollution, but primarily a guide to other sources.

Wallace, David Rains. 1987. *Life in the Balance*.* Harcourt Brace Jovanovich, Inc. New York. The companion volume to the Audubon television series. Excellent reading for the nonscientist. Provides further background on the subjects covered in this guide.

Young, Stanley P. and Edward Goldman. 1946. *The Puma, Mysterious American*. Dover Publications Inc. New York. Dated but valuable survey of mountain lion natural history. Quite readable though at times dry. Still in print.

Map of the United States

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The National Audubon Society, founded in 1905, is dedicated to conserving plants and animals and their habitats, to promoting wise use of land, water, and energy, and to protecting life from the many global environmental problems that now threaten it. With more than half a million members, five hundred local chapters, and a staff of nearly three hundred, National Audubon is a powerful force for conservation, education, and action.

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